



Allen-Bradley

ControlLogix® Redundancy System

User Manual

**Rockwell
Automation**

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WARNING



Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION



Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

Introduction

This release of this document contains new and updated information. To find new and updated information, look for change bars, as shown next to this paragraph.

Updated Information

The document contains the following changes:

This new or updated information:	See:
New chapter that gives an overview of the ControlLogix® redundancy system, including basic operation, switchover, synchronization, crossloading, handling of ControlNet™ addresses, and quick start checklists	Chapter 1
Expanded guidelines on how to lay-out a system	Chapter 2
Recommendations for the number of ControlNet networks	
Recommendations for the number of PanelView terminals	
Restrictions on the networks for I/O	
Optional components for a redundancy system	
Restrictions on the use of a network access port (NAP)	Chapter 3
Download a project	
Schedule a ControlNet network	
When to retain test edits	Chapter 4
How to estimate scan time	
Tips to minimize scan time	
Troubleshoot a failure to synchronize	Chapter 5
Update keeper signatures	
Tips to optimize communication performance	
Interpret the 4-character display of a CNB module	
Export SRM events to Microsoft® Excel	
Get system values (reorganized to make it easier to use)	Appendix A
Store or load a project using nonvolatile memory	
Bill of materials (moved to an appendix)	
Convert an non-redundant system to a redundant system (moved to an appendix)	Appendix B
Glossary of common terms	Glossary

Notes:

Purpose of this Manual

This manual guides the design, development, and implementation of a redundancy system for a ControlLogix® controller.

Who Should Use this Manual

This manual is intended for those individuals who design and develop applications that use ControlLogix controllers, such as:

- software engineers
- control engineers
- application engineers
- instrumentation technicians

When to Use This Manual

Use this manual throughout the life-cycle of a redundancy system:

- design
- installation
- configuration
- programming
- testing
- maintenance and troubleshooting

How to Use this Manual

This manual is divided into the basic tasks that you perform during the design, development, and implementation of a ControlLogix redundancy system.

- Each chapter covers a task.
- The tasks are organized in the sequence that you will typically perform them.

As you use this manual, you will see some text that is formatted differently from the rest of the text:

Text that is:	Identifies:	For example:	Means:
<i>Italic</i>	the actual name of an item that you see on your screen or in an example	Right-click <i>User-Defined</i> ...	Right-click on the item that is named User-Defined.
<code>courier</code>	information that you must supply based on your application (a variable)	Right-click <code>name_of_program</code> ...	You must identify the specific program in your application. Typically, it is a name or variable that you have defined.
■ enclosed in brackets	a keyboard key	Press [Enter].	Press the Enter key.

Notes:

ControlLogix® Redundancy Overview

Chapter 1

Introduction	1-1
Basic Operation	1-1
Switchover	1-2
Synchronization	1-4
Crossloading Tag Values	1-5
ControlNet Node Addresses	1-6
Quick Start Checklists	1-7
System Lay-Out	1-7
Redundant Chassis Configuration	1-8
RSLogix™ 5000 Project	1-8

Design the System

Chapter 2

How to Use this Chapter	2-1
Lay Out the System	2-2
Place the I/O	2-4
Add Additional Redundant Components	2-5
Redundant ControlNet Media	2-5
Redundant Power Supplies	2-6
Check Connection Requirements	2-6
Assign ControlNet Addresses	2-7
Select a Network Update Time	2-9
Estimate the Switchover Time	2-11

Install the System

Chapter 3

When to Use this Chapter	3-1
How to Use this Chapter	3-1
Preliminary Information	3-1
Install the Chassis for the Controllers	3-4
Install Modules in the First Redundant Chassis	3-5
Install Modules in the Second Redundant Chassis	3-7
Install the Remote Chassis or Rails	3-8
Flash the Modules	3-9
Synchronize the Controllers	3-10
Set the Auto-Synchronization Option to <i>Always</i>	3-10
Synchronize the Controllers	3-11
Download the Project to the Primary Controller	3-12
Schedule the Networks	3-13
Schedule a New Network	3-13
Update the Schedule of an Existing Network	3-15
Check the Keepers	3-16
Save the Project for Each Controller	3-16
Test the Switchover	3-17
Make Sure the Auto-Synchronization Option = <i>Always</i>	3-17
Initiate a Switchover	3-18

Make Sure the Controllers are Synchronized	3-18
--	------

Configure and Program the Controller

Chapter 4

When to Use this Chapter	4-1
How to Use this Chapter	4-1
Configure the Project for the Controllers	4-2
Determine When to Retain Test Edits	4-2
Determine How to Reserve Memory	4-3
Configure a Controller for Redundancy	4-4
Configure Communications	4-6
Configure I/O	4-6
Configure Produced Tags	4-7
Configure Message (MSG) Instructions	4-8
Configure Tags for an HMI	4-8
Estimate the Scan Time of a Program	4-9
Minimize Scan Time	4-10
Use a Few Large Programs	4-10
Minimize the Use of SINT or INT tags	4-10
Use Arrays and User-Defined Data Types	4-11
Pack Data into Arrays	4-11
Execute Instructions Only When Required	4-13
Maintain the Integrity of Your Data During a Switchover . .	4-15
Look for Array Shift Instructions	4-17
Look for Logic That is Scan-Dependant	4-18
Take Preventative Actions	4-19
Set the Task Watchdog Times	4-20
Estimate a Watchdog Time	4-20
Set the Watchdog Time for a Task	4-21
Determine the Scan Time of a Task	4-22

Maintain and Troubleshoot the System

Chapter 5

When to Use this Chapter	5-1
How to Use this Chapter	5-1
Determine the Cause of a Switchover	5-2
Troubleshoot a Failure to Synchronize	5-3
Update a Keeper Signature	5-4
Check the Recent Synchronization Attempts	5-5
Manually Synchronize the Controllers	5-6
Optimize Communication	5-7
Choose a Greater System Overhead Time Slice	5-8
Enter a System Overhead Time Slice	5-9
Make All Your Tasks Periodic	5-10
Adjust CNB Usage	5-11
Use RSLinx Software	5-12
Look at the Four Character Display	5-13

Send a Message to the CNB Module	5-14
Export the SRM Event Log to Microsoft® Excel.	5-15
Export Events to a CSV File	5-15
Open and Format the CSV File	5-17
Configure the Auto-Synchronization Option	5-18
Choose an Auto-Synchronization Option.	5-18
Configure the Auto-Synchronization Option	5-18
Get System Values	5-20
Send a Message to an SRM Module	5-24
Configure the 1757-SRM Module.	5-25
Enter the Message Instruction.	5-26
Configure the Message Instruction	5-27
Store or Load a Project Using Nonvolatile Memory	5-30
Update a Module	5-31
Disqualify the Secondary Chassis	5-31
Upgrade the Required Firmware of the Secondary Chassis.	5-32
Make the Secondary Controller the New Primary Controller.	5-33
Upgrade the Other Redundant Chassis	5-33
Change the Auto-Synchronization Option to <i>ALWAYS</i>	5-34

Appendix A

Develop the Bill of Materials

Redundant Controller Chassis	A-1
Additional Materials.	A-1

Appendix B

Convert an Existing System to Redundancy

Introduction	B-1
Convert Local Modules to Remote Modules	B-1
Re-Configure the Local I/O Modules.	B-2
Replace Local I/O Tags	B-2
Replace any Aliases to Local I/O Tags.	B-4

ControlLogix® Redundancy Overview

Introduction

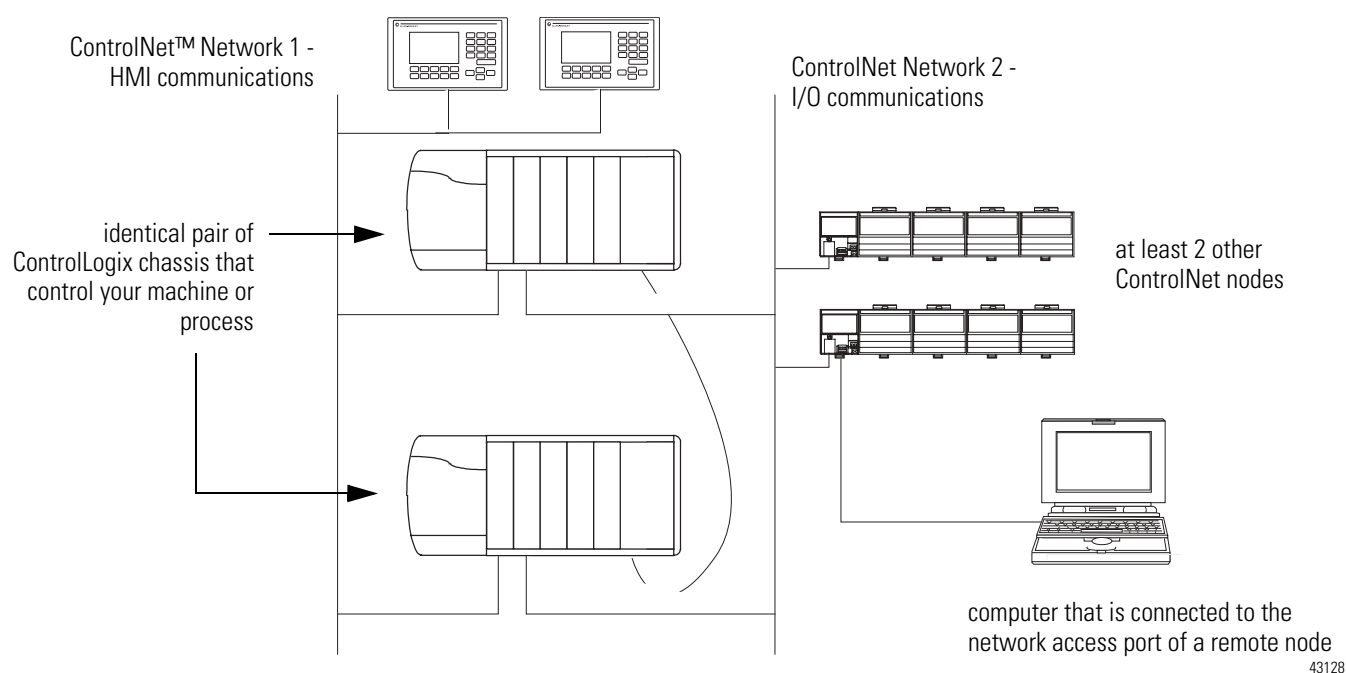
This chapter gives you an overview of the ControlLogix redundancy system, including terms that are commonly used.

For information on:	See page:
Basic Operation	1-1
Switchover	1-2
Synchronization	1-4
Crossloading Tag Values	1-5
ControlNet Node Addresses	1-6
Quick Start Checklists	1-7

Basic Operation

The ControlLogix redundancy system uses an identical pair of ControlLogix chassis to keep your machine or process running if a problem occurs with a controller.

The following diagram shows the layout of a simple redundant set-up.



Redundancy requires no additional programming and is transparent to any devices connected over the ControlNet™ network. It uses 1757-SRM modules to maintain communication between the pair of redundant chassis.

In a redundant system, the following terms describe the relationship between the two redundant chassis:

Term:	Description:
primary controller	The controller that is currently controlling the machine or process.
primary chassis	The chassis that contains the primary controller.
secondary controller	The controller that is standing by to take control of the machine or process. A secondary controller always resides in a different chassis than the primary controller.
secondary chassis	The chassis that contains the secondary controller.
switchover	Transfer of control from the primary controller to the secondary controller. After a switchover, the controller that takes control becomes the primary controller. Its partner controller (the controller that was previously the primary controller) becomes the secondary controller.

Switchover

When a failure occurs in any of the components of the primary chassis, control switches to the secondary controller. A switchover occurs for any of the following reasons:

- any of the following situations *in the primary chassis*:
 - loss of power
 - failure or major fault of the controller
 - failure of a 1756-CNB/D or -CNBR/D module
 - failure of a 1757-SRM module
 - break or disconnection of a ControlNet tap
 - removal or insertion of a module
- command from the primary controller
- command from RSLinx® software

IMPORTANT**Use of the Network Access Port (NAP)**

Do not connect any device to the network access port (NAP) of a 1756-CNB/D or -CNBR/D module in a redundant chassis.

- If you connect a device to the NAP of a CNB module in a redundant chassis, a switchover will fail to occur if the CNB module is disconnected from the network. While the CNB module is disconnected from the network, the controller will be unable to control any I/O devices through that CNB module.
- If you connect a workstation to the NAP of a CNB module in a redundant chassis, the workstation will be unable to go online after a switchover.

To connect a device to a ControlNet network via a NAP, use a NAP that is outside of a redundant chassis.

Depending on how you organize your RSLogix™ 5000 project, outputs may or may not experience a change in state (bump) during a switchover:

- During the switchover, outputs that are controlled by the highest priority task will experience a bump-less switchover. (i.e., Outputs will not revert to a previous state.)
- Outputs in lower priority tasks *may* experience a change of state.

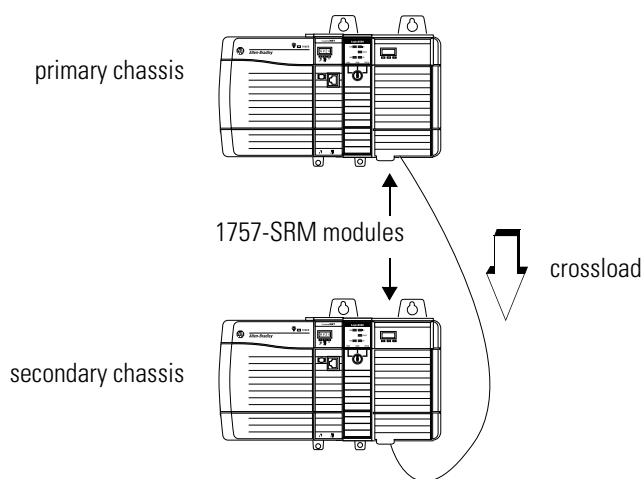
The switchover time of a redundant system depends on the type of failure and the network update time (NUT) of the ControlNet network. For a NUT of 10 ms, the switchover time is approximately 80 ms to 220 ms.

Synchronization

To take over control, the secondary controller requires the same project as the primary controller. It also requires up-to-date tag values. The following terms describe the process of communication between the two controllers.

Term:	Description:
crossload	The transfer of any or all of the contents of the primary controller to the secondary controller. This could be updated tag values, force values, online edits, or any other information about the project. A crossload occurs initially when the controllers synchronize and then repeatedly as the primary controller executes its logic.
synchronize	The process that readies a secondary controller to take over control if a failure occurs in the primary chassis. During synchronization, the 1757-SRM modules check that the partner modules in the redundant chassis pair are compatible with each other. The SRM module also crossloads (transfers) the content of the primary controller to the secondary controller. Synchronization occurs when you turn on power to the secondary chassis. It may also occur at other times.
disqualified	Indicates that the secondary control has failed to synchronize with the primary controller. If a secondary controller is disqualified, it is unable to take over control of the machine or process. You also have the option of manually disqualifying a secondary controller.

The 1757-SRM modules maintain communication between the primary and secondary chassis.



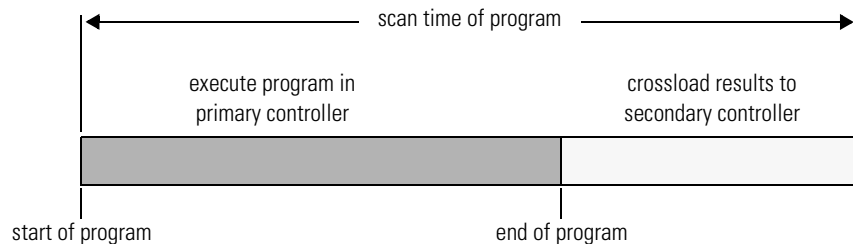
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In a pair of redundant chassis, the first chassis that you turn on becomes the primary chassis. When you turn on power to the secondary chassis, that chassis synchronizes itself with the primary chassis.

- You do not download the project to the secondary controller. While the secondary controller is synchronizing with the primary controller, the 1757-SRM modules automatically transfer the project from the primary controller to the secondary controller.
- Once the secondary controller is synchronized, the 1757-SRM modules keep the controller synchronized by crossloading any changes that occur in the primary controller. These changes include:
 - online edits
 - force values
 - changes to properties
 - changes to data
 - results of logic execution
- Although online edits automatically crossload to the secondary controller, they become inactive if a switchover occurs before you assemble them into the project. This prevents an incorrect online edit from faulting both the primary and secondary controller. You have the option to keep the edits active after a switchover (at the risk of faulting both controllers).

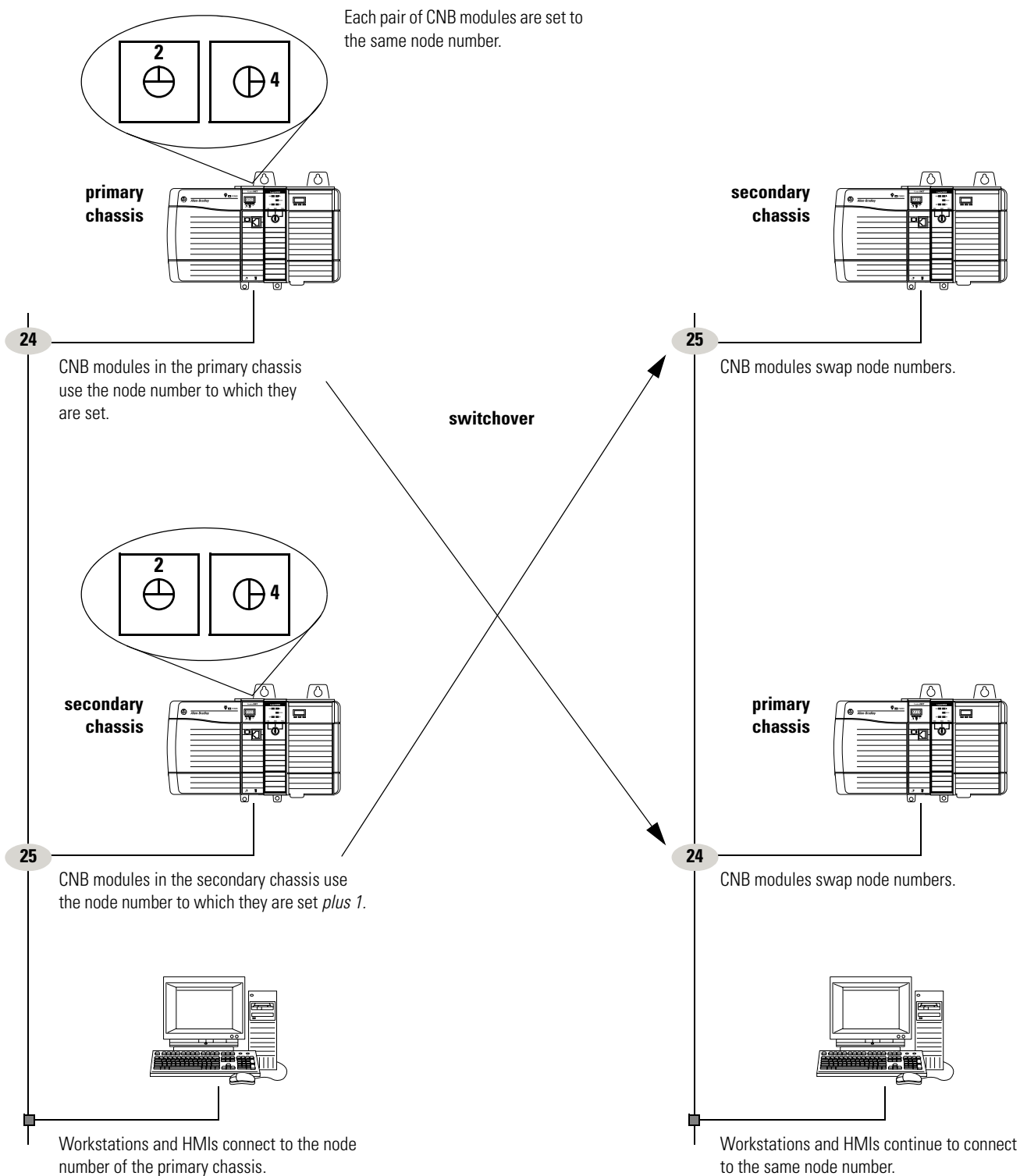
Crossloading Tag Values

At the end of each program, the primary controller pauses its execution to crossload the result of any output instruction that executed in the program. This results in an increased program scan time for a synchronized redundancy system.



ControlNet Node Addresses

Each CNB module in a redundant chassis shares a pair of ControlNet node numbers with its partner in the other chassis.



Quick Start Checklists

The following checklists provide a summary of the criteria for a successful ControlLogix redundancy system. See the remaining chapters for more information on each parameter.

System Lay-Out

Parameter:	Criteria:	See page:
☐ 1. Type of network	ControlNet™ networks are the primary networks for the system. OK to bridge to devices on other networks, such as EtherNet/IP, DeviceNet™, Universal Remote I/O, and DH+™ networks.	2-2
☐ 2. Number of ControlNet networks	Separate ControlNet networks for scheduled communications (I/O, produced/consumed tags) and unscheduled communications (HMI, workstations, message instructions)	2-2
☐ 3. Network update times	• NUTs $\leq$ 90 ms • NUTs $\leq$ specified relationship to each other	2-9
☐ 4. I/O Placement	• All I/O modules in remote chassis or DIN rails (no I/O in the local chassis) • All I/O in <i>only</i> the following locations: • same ControlNet network as the redundant controllers (no bridging) • DeviceNet™ network (via a 1756-DNB module in a remote chassis) • universal remote I/O network (via a 1756-DHIRO module in a remote chassis)	2-2, 2-4
☐ 5. Number of ControlNet nodes	At least 2 nodes on each network in addition to the CNBs in the redundant chassis (i.e., Each ControlNet network has at least 4 nodes.)	2-7
☐ 6. ControlNet node assignments	• Non-redundant nodes use the lowest node numbers • CNB modules in the redundant chassis set close to the SMAX. • 2 consecutive node addresses for each set of partner CNB modules (one in each chassis) • Switches of each partner CNB module set to the same node address	1-6, 2-7
☐ 7. PanelView™ terminals	• $\leq$ 3 terminals per CNB module • $\leq$ 4 terminals per controller	2-2
☐ 8. Network Access Ports	No devices connected to the network access ports of CNB modules in the redundant chassis	2-2

Redundant Chassis Configuration

Parameter:	Criteria:	See page:
☐ 1. Chassis size	Same size chassis for each pair of redundant chassis.	2-9
☐ 2. Chassis lay-out	- Only the following modules in each redundant chassis (no other modules): 1 controller 1 to 5 CNB modules 1 SRM module (requires 2 slots) - Same slot assignments in each chassis	2-9
☐ 3. Controllers	1756-L55M13, -L55M14, -L55M16, -L55M23, or -L55M24 controller: - Identical controllers for each redundant pair (same catalog number, series, revision, and memory size) - Enough memory for 2 copies of all data.	2-3
☐ 4. Connections	Redundant controller requires 7 connections for redundancy.	2-6
☐ 5. CNB modules	1756-CNB/D or -CNBR/D module or modules: - Identical modules for each redundant pair (same catalog number, series, and revision) - CPU usage $\leq 75\%$ - CNB modules have the same keeper information	2-9, 5-4
☐ 6. SRM modules	1757-SRM module: - Identical modules for each redundant pair (same catalog number, series, and revision) - only 1 in each redundant chassis - Uses 2 slots - Requires 1757-SRCx cable (1, 3, 10, 50, and 100 meter lengths)	2-9

RSLogix™ 5000 Project

Parameter:	Criteria:	See page:
☐ 1. Number of projects	Only one RSLogix 5000 project for the pair of redundant controllers. The project automatically crossloads to the secondary controller when the secondary controller synchronizes with the primary controller.	4-1
☐ 2. Controller properties	1756-L55 ControlLogix5555 controller - Redundancy enabled	4-2
☐ 3. Task structure	- Only one task at the highest priority - If more than one task, all tasks periodic	4-6, 5-7
☐ 4. I/O	- Outputs that require a bumpless switchover are in the highest priority task - Requested packet interval (RPI) less than or equal to 375 milliseconds. (Larger RPIs may produce a bump at switchover.)	4-6
☐ 5. Task watchdog time	Watchdog time $\geq (2 * \text{maximum\_scan\_time}) + 100 \text{ ms}$ where: <i>Maximum_scan_time</i> is the maximum scan time for the entire task when the secondary controller is synchronized.	4-20

RSLogix™ 5000 Project (Continued)

Parameter:	Criteria:	See page:
☐ 6. Minimizing scan time	• A few large programs • Minimal use of SINT or INT tags • Related data in arrays and user-defined data types • Boolean data in BOOL arrays • Instructions execute only when required	4-10
☐ 7. Data integrity	Special treatment for: • Bit Shift Left (BSL) and Bit Shift Right (BSR) instructions • FIFO Unload (FFU) instructions • Logic that is scan-dependant	4-15
☐ 8. Produced and consumed tags	If you want a controller in another chassis to consume a tag from the redundant controller, use a comm format of None. In the I/O configuration of the consuming controller, select a comm format of None for the remote CNB module (the CNB that is physically in the redundant chassis).	4-6
☐ 9. Message (MSG) instructions	For any MSG instruction from a controller in another chassis to a redundant controller, cache the connection.	4-6

Notes:

Design the System

Use this chapter to design a redundancy system for a ControlLogix controller

How to Use this Chapter

To design your system, complete the following tasks:

Task:	See page:
☐ Lay Out the System	2-2
☐ Place the I/O	2-4
☐ Add Additional Redundant Components	2-5
☐ Check Connection Requirements	2-6
☐ Assign ControlNet Addresses	2-7
☐ Select a Network Update Time	2-9
☐ Estimate the Switchover Time	2-11

Lay Out the System

Figure 2.1 ControlLogix redundancy requirements and recommendations

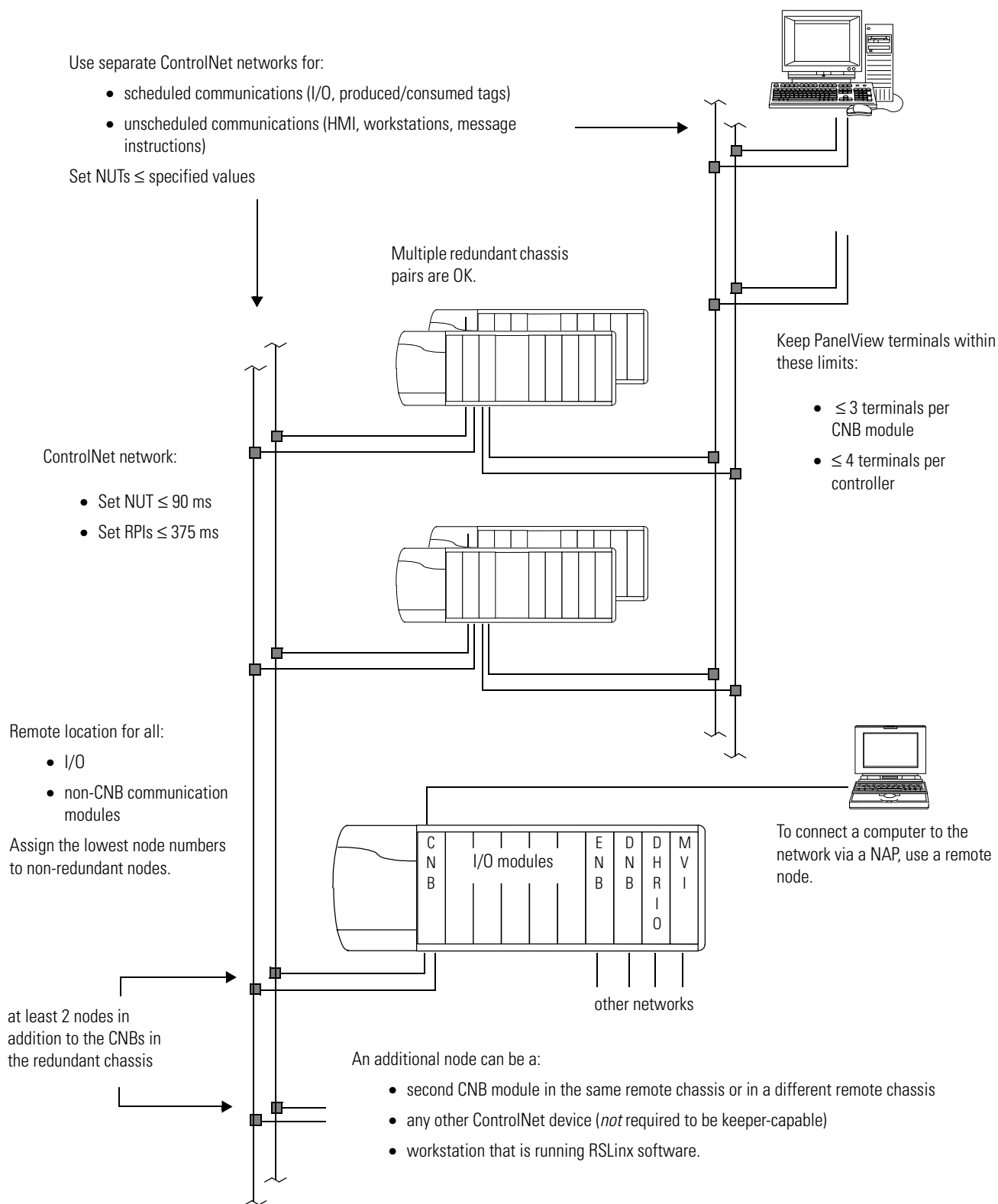
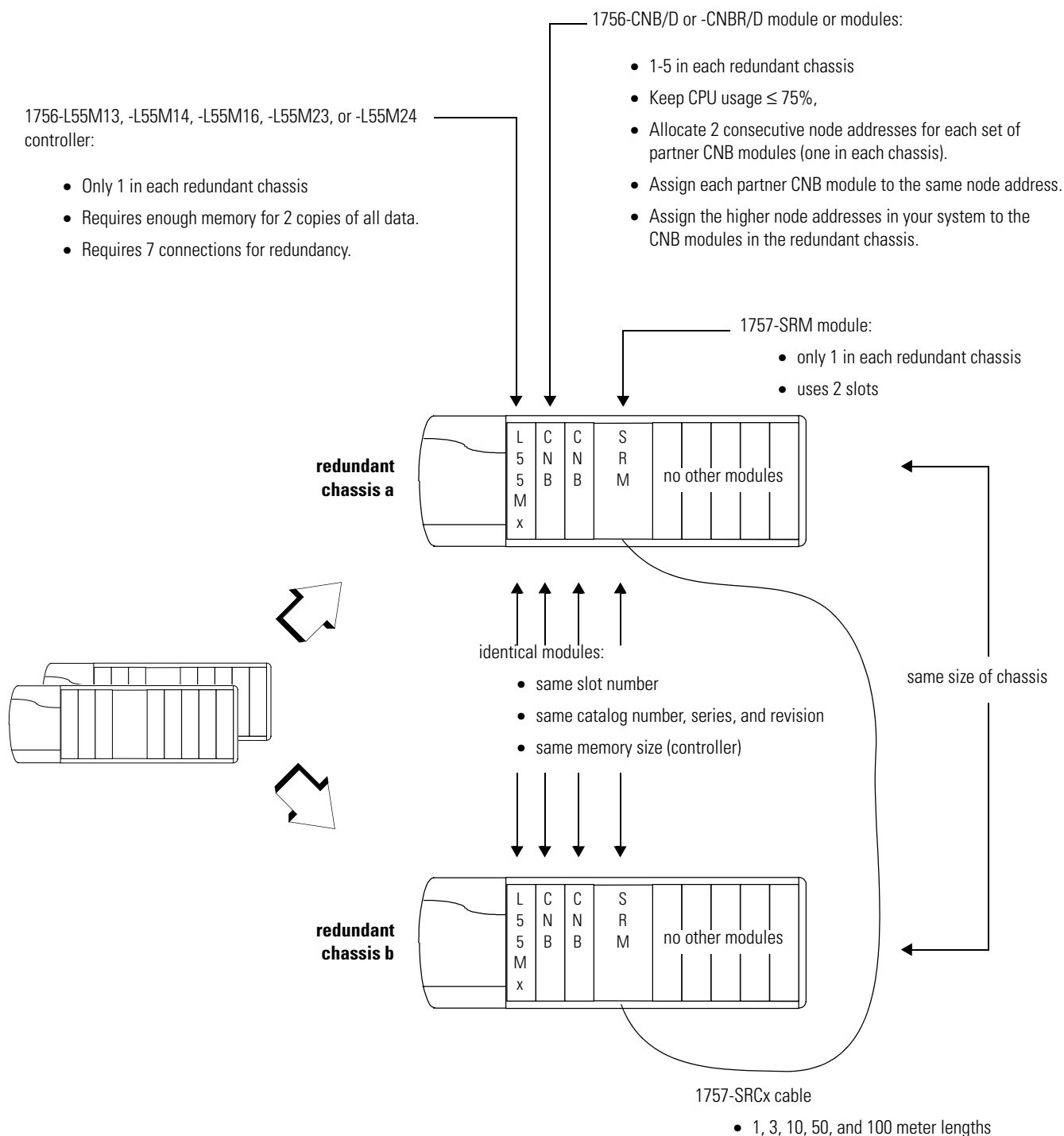


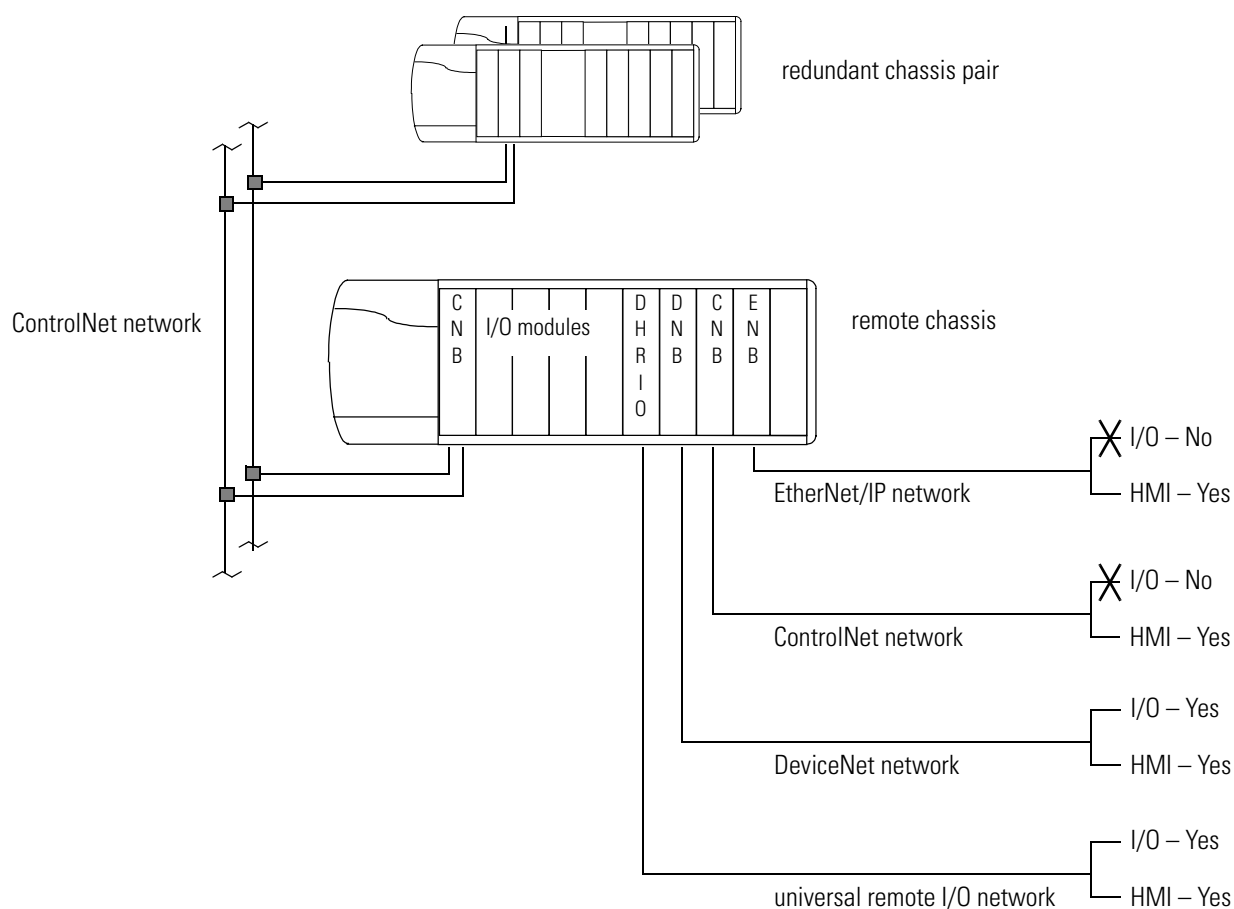
Figure 2.2 ControlLogix redundancy requirements and recommendations (Continued)



Place the I/O

In a ControlLogix redundancy system, place all I/O in *only* the following locations:

- ✓ same ControlNet network as the redundant controllers (no bridging to I/O modules on another ControlNet network)
- ✓ DeviceNet network
- ✓ universal remote I/O network



Add Additional Redundant Components

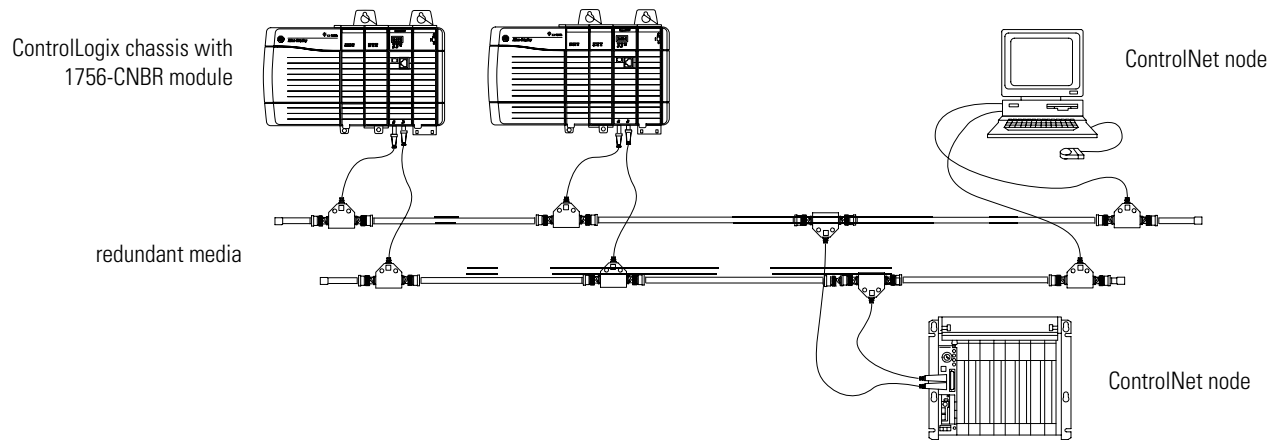
In addition to using redundant pairs of controllers, you have the option of adding the following redundant components to your system:

- Redundant ControlNet Media
- Redundant Power Supplies

Redundant ControlNet Media

Redundant ControlNet media prevents a loss of communication if a trunkline or tap is severed or disconnected. It uses the following components:

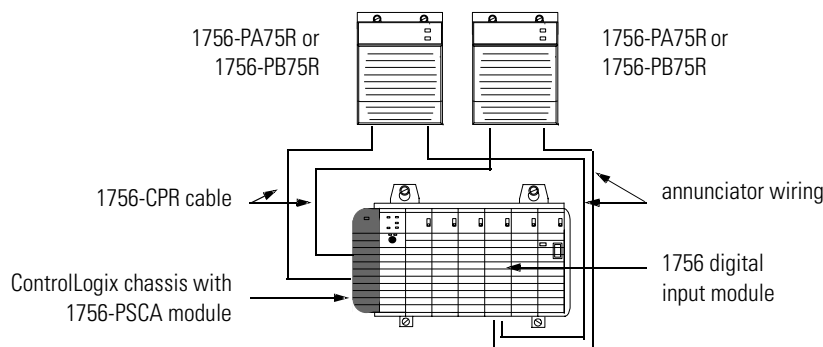
- 1756-CNBR ControlNet modules
- two identical ControlNet links



Redundant Power Supplies

Redundant power supplies let you maintain power to a ControlLogix chassis if a power supply fails. Redundant power supplies use the following hardware:

- two redundant power supplies, any combination of 1756-PA75R and 1756-PB75R
- 1756-PSCA chassis adapter module, in place of the standard power supply
- two 1756-CPR cables to connect the power supplies to the 1756-PSCA adapter
- user-supplied annunciator wiring to connect the power supplies to the input modules, if needed



Check Connection Requirements

Make sure that each controller in a redundant chassis has available enough connections for redundancy communications. Redundancy communications require the following number of additional connections:

This module:	Uses this many additional connections for redundancy:	Description:
controller	7	2 for the SRM
		5 for the partner

Assign ControlNet Addresses

IMPORTANT

1. Make sure that your network has at least 2 nodes in addition to the redundant chassis pair. An additional node can be a:

- second CNB module in the same remote chassis or in a different remote chassis
- any other ControlNet device
- workstation that is running RSLinx software.

If your ControlNet network contains only one node other than the redundant chassis pair, that node will drop its connections during a switchover. This may cause the outputs of that node to change state during the switchover.

IMPORTANT

2. Assign the lowest ControlNet addresses to I/O chassis and other remotely-located chassis. (I.e., *Do not* assign the lowest addresses to the redundant chassis pair.)

If you assign the lowest address to a CNB module in the redundant chassis pair:

- On a switchover, you may temporarily lose communication with I/O modules, produced tags, and consumed tags.
 - If you remove the CNB module from the primary chassis while chassis power is on, you may temporarily lose communication with I/O modules, produced tags, and consumed tags.
 - If every ControlNet node powers down at the same time (e.g., a plant-wide power loss), you may have to cycle the power to the primary chassis to restore communication.
-

3. Allocate two consecutive ControlNet addresses for each pair of redundant chassis (e.g., nodes 3 and 4).
 - If each redundant chassis has multiple CNB modules, assign a pair of node numbers for each pair of CNB modules (one in each chassis).
 - Do not configure any other device on the ControlNet network for either of these addresses. For example, if you allocated nodes 3 and 4 for the redundant chassis, then no other device should use those node numbers.

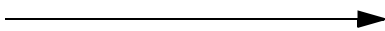
Use the following worksheet to record the slot number and node numbers for each pair of CNB modules:

Table 2.1 Slot and node numbers for 1756-CNB/D or -CNBR/D modules

Pair of CNB modules (one in each redundant chassis)	Slot and node numbers		
	Slot #	Primary node #	Secondary node # (primary node # + 1)
1st pair of CNB modules			
2nd pair of CNB modules			
3rd pair of CNB modules			
4th pair of CNB modules			
5th pair of CNB modules			

Select a Network Update Time

Use a network update time (NUT) that is less than or equal to the following values.

If you have:	And:	Then:
only one CNB module in a redundant chassis		Use a NUT that is less than or equal to 90 milliseconds.
more than one CNB module in a redundant chassis	the CNB modules are on the same network	Use a NUT that is less than or equal to 90 milliseconds.
	the CNB modules are on different networks	The NUT of each network must be within the values indicated in Table 2.2.

If you use a larger NUT, the controller could lose its connection with a module during a switchover. This could cause outputs to change state.

Table 2.2 NUTs for multiple ControlNet networks

If the smallest NUT on a network is (ms):	Then the largest NUT on any other network must be less than or equal to (ms):
2	15
3	17
4	19
5	21
6	23
7	25
8	27
9	29
10	31
11	33
12	35
13	37
14	39
15	41
16	43
17	46
18	48
19	50

Table 2.2 NUTs for multiple ControlNet networks (Continued)

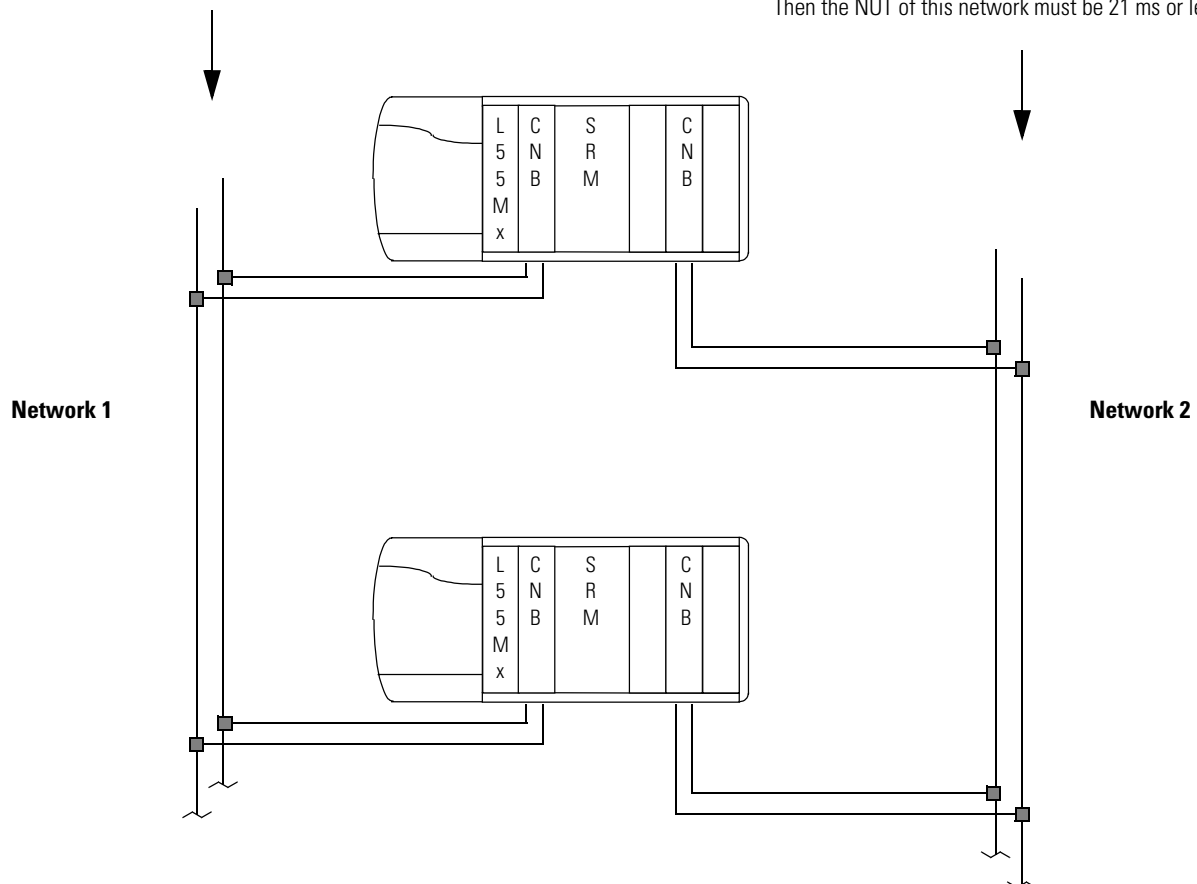
If the smallest NUT on a network is (ms):	Then the largest NUT on any other network must be less than or equal to (ms):
20	52
21	55
22	57
23	59
24	62
25	64
26	66
27	68
28	71
29	73
30	75
31	78
32	80
33	82
34	84
35	87
36	89
37 - 90	90

EXAMPLE

Network Update Times for Multiple ControlNet Networks

If the NUT of this network is 5 ms...

Then the NUT of this network must be 21 ms or less.



Estimate the Switchover Time

The switchover time of a redundant system depends on the network update time (NUT) of the ControlNet network. To estimate the switchover time, use the following formulas:

For this type of failure:	If the NUT is:	The switchover time is:	Example:
loss of power – or – module failure	≤ 6	60 ms	For a NUT of 4 ms, the switchover time is approximately 60 ms.
	≥ 7	$5 (NUT) + \text{MAX} (2 (NUT), 30)$	For a NUT of 10 ms, the switchover time is approximately 80 ms.
CNB module cannot communicate with any other node	—————▶	$14 (NUT) + \text{MAX} (2 (NUT), 30) + 50$	For a NUT of 10 ms, the switchover time is approximately 220 ms.

where:

NUT is the network update time of the network.

Notes:

Install the System

When to Use this Chapter

Use this chapter to install the hardware of your ControlLogix redundancy system.

How to Use this Chapter

To install your system, complete the following tasks:

Task:	See page:
☐ Review the Preliminary Information	3-1
☐ Install the Chassis for the Controllers	3-4
☐ Install Modules in the First Redundant Chassis	3-4
☐ Install Modules in the Second Redundant Chassis	3-4
☐ Install the Remote Chassis or Rails	3-4
☐ Flash the Modules	3-4
☐ Synchronize the Controllers	3-10
☐ Download the Project to the Primary Controller	3-12
☐ Schedule the Networks	3-13
☐ Test the Switchover	3-17

Preliminary Information

IMPORTANT

Use of the Network Access Port (NAP)

Do not connect any device to the network access port (NAP) of a 1756-CNB/D or -CNBR/D module in a redundant chassis.

- If you connect a device to the NAP of a CNB module in a redundant chassis, a switchover will fail to occur if the CNB module is disconnected from the network. While the CNB module is disconnected from the network, the controller will be unable to control any I/O devices through that CNB module.
- If you connect a workstation to the NAP of a CNB module in a redundant chassis, the workstation will be unable to go online after a switchover.

To connect a device to a ControlNet network via a NAP, use a NAP that is outside of a redundant chassis.

This chapter provides the sequence of tasks and the critical actions for the successful installation of your ControlLogix redundancy system. It *does not* replace the installation instructions for the components of the system. As you install your system, refer to the following publications:

Install this component:	According to this publication:
1756-A4, -A7, -A10, -A13, or -A17 chassis	<i>ControlLogix Chassis Installation Instructions</i> , publication 1756-IN080
1756-PA72 or -PB72 power supply	<i>ControlLogix Power Supplies Installation Instructions</i> , publication 1756-5.67
1756-PA75 or -PB75 power supply	<i>ControlLogix Power Supplies Installation Instructions</i> , publication 1756-5.78
1756-L55M13, -L55M14, or -L55M16 controller	<i>ControlLogix Controller and Memory Board Installation Instructions</i> , publication 1756-IN101
1756-CNB/D or -CNBR/D module	<i>ControlLogix ControlNet Bridge Installation Instructions</i> , publication 1756-IN571
1757-SRM module	<i>ProcessLogix/ControlLogix System Redundancy Module Installation Instructions</i> , publication 1757-IN092

Installation instructions provide important information, such as detailed installation steps, safety considerations, enclosure requirements, and hazardous location information.

Before you install the system, review the following guidelines for safe handling of ControlLogix components:

WARNING

When you insert or remove a module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

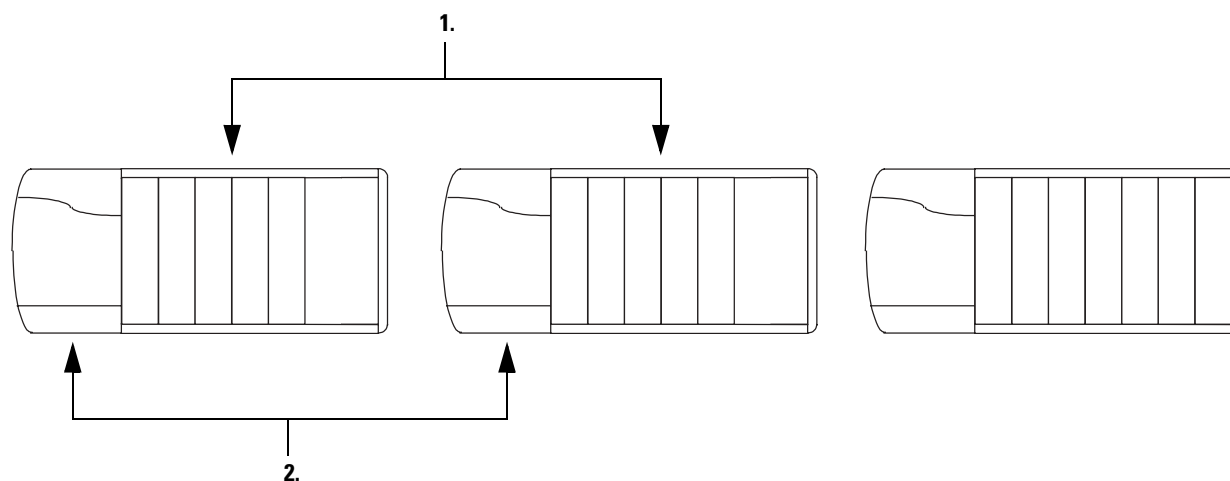
Repeated electrical arcing causes excessive wear to contacts on both a module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

ATTENTION**Preventing Electrostatic Discharge**

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
 - Wear an approved grounding wriststrap.
 - Do not touch connectors or pins on component boards.
 - Do not touch circuit components inside the equipment.
 - If available, use a static-safe workstation.
 - When not in use, store the equipment in appropriate static-safe packaging.
-

Install the Chassis for the Controllers



42798

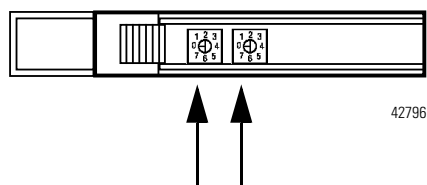
1. Install the two ControlLogix chassis that will contain the controllers (i.e., the redundant chassis):
 - Place the chassis within the length of your 1757-SRCx cable.
 - Install each chassis according to the *ControlLogix Chassis Installation Instructions*, publication 1756-IN080.
 - If you are converting an existing system that contains local I/O modules, you still need two additional chassis. A redundant system can use only remote I/O.
2. For each chassis, install a ControlLogix power supply according to the corresponding installation instructions:

Install this power supply:	According to this publication:
1756-PA72	<i>ControlLogix Power Supplies Installation Instructions</i> , publication 1756-5.67
1756-PB72	
1756-PA75	<i>ControlLogix Power Supplies Installation Instructions</i> , publication 1756-5.78
1756-PB75	

Install Modules in the First Redundant Chassis

IMPORTANT

Set the rotary switches of the 1756-CNB/D or -CNBR/D modules for both redundant chassis to the same node address.



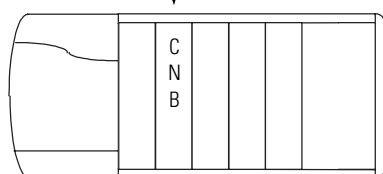
42796

1. Set the rotary switches of each of the 1756-CNB/D or -CNBR/D modules to the primary node number from Table 2.1 on page 2-8.

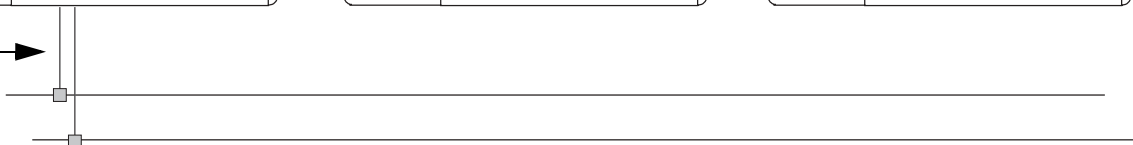
For example, if you allocated nodes 3 and 4 for the redundant chassis, set both CNB modules to node 3.

2.

This is only an example. You can install the module in any slot.



3.



42799

2. Install a 1756-CNB/D or -CNBR/D module. See *ControlLogix ControlNet Bridge Installation Instructions*, publication 1756-IN571.

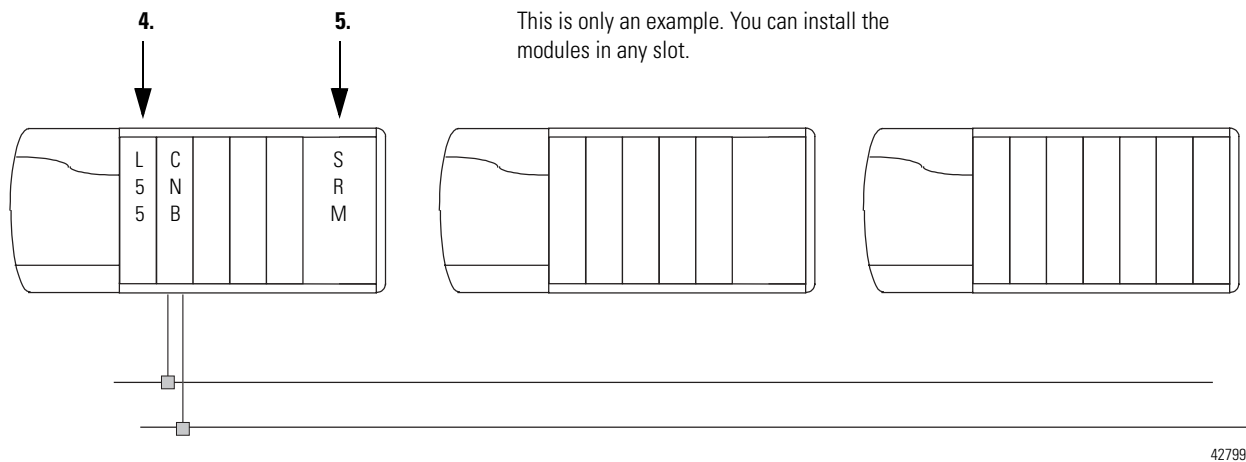
WARNING



If you connect or disconnect the ControlNet cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

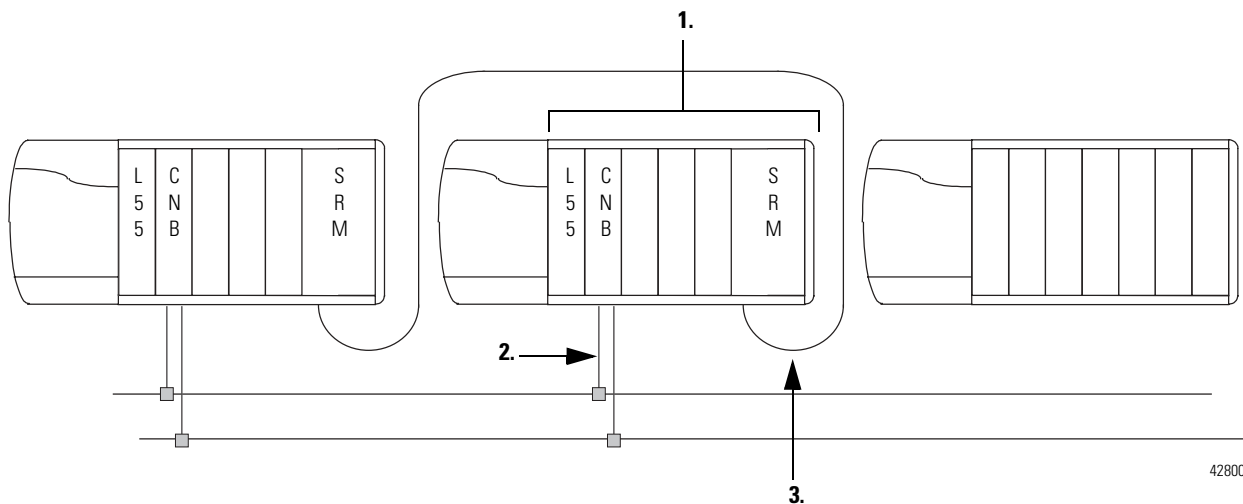
Be sure that power is removed or the area is nonhazardous before proceeding.

3. Connect the CNB module to the ControlNet network.



4. Install the 1756-L55Mxx controller. See *ControlLogix Controller and Memory Board Installation Instructions*, publication 1756-IN101.
5. Install the 1757-SRM module. See *ProcessLogix/ControlLogix System Redundancy Module Installation Instructions*, publication 1757-IN092.

Install Modules in the Second Redundant Chassis

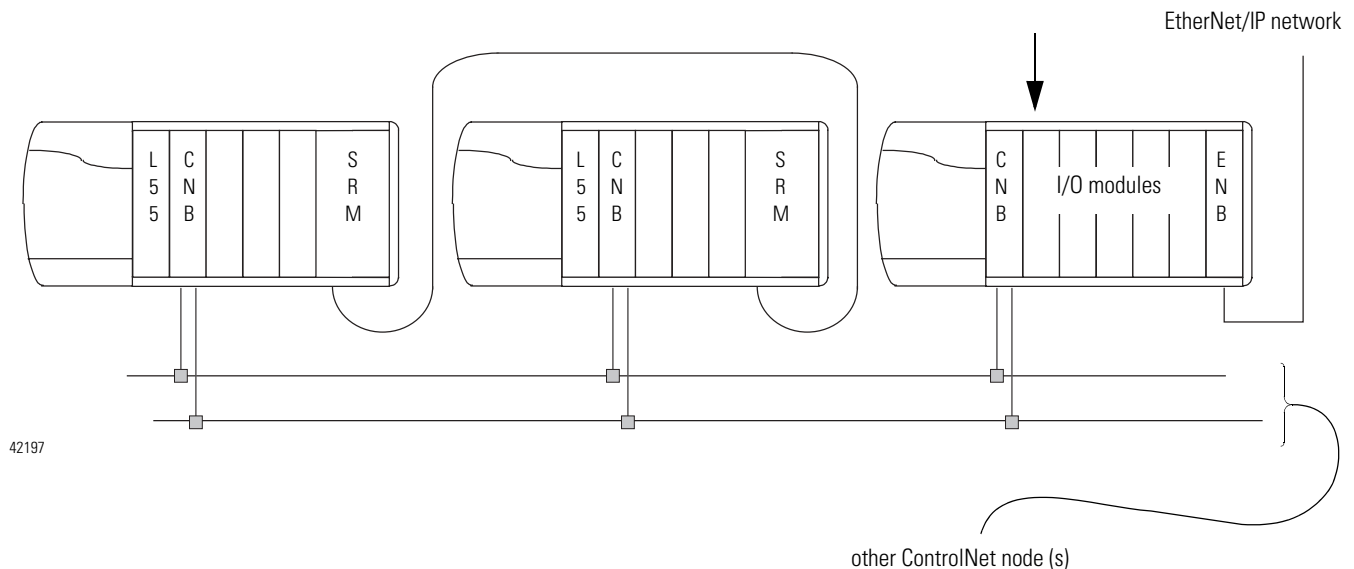
**IMPORTANT**

- The modules in each redundant chassis must match each other slot-by-slot.
- Set the rotary switches of the 1756-CNB/D or -CNBR/D modules for both redundant chassis to the same node address.

1. For each module in the first redundant chassis, install an identical module into the same slot of the second redundant chassis.
2. Connect the CNB module (s) to the ControlNet network.
3. Connect the 1757-SRC1, -SRC3, -SRC10, -SRC50, or -SRC100 fiber optic cable to the 1757-SRM modules.

Install the Remote Chassis or Rails

You must install all I/O modules and additional types of communication modules in remote chassis or on DIN rails. The following example shows a remote 1756 chassis. You can use any type of chassis or device that you can connect to the ControlNet network.



You must have at least 2 other nodes in addition to the redundant chassis pair. See "Lay Out the System" on page 2-2.

IMPORTANT

If you connect the workstation to the network via a network access port on a CNB module, use a CNB module in a remote chassis. This lets a switchover occur after the failure of a ControlNet tap of a primary chassis.

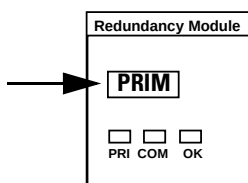
As you install the chassis, follow these guidelines:

- Do not assign any device to the address of the CNB modules in the redundant chassis plus one.

For example, if you set the rotary switches of the CNB modules in the redundant chassis to node 11, no other device should use node 12.

- Use a remote chassis for communication modules such as:
 - 1756-ENET or -ENB
 - 1756-DHRIO
 - 1756-MVI
 - 1756-DNB

Flash the Modules



42801

1. Turn on the power to one of the redundant chassis.
2. Wait for the 1757-SRM module to display PRIM.
3. Flash upgrade each module in the chassis with a compatible revision of firmware.
 - See the *ControlFLASH Firmware Upgrade Kit User Manual*, publication 1756-6.5.6.
 - To find the chassis in RSLinx software, use the node number that the CNB module in the chassis displays.
4. Turn off the power to the chassis.
5. Turn on the power to the second redundant chassis.
6. Wait for the 1757-SRM module to display PRIM.
7. Flash upgrade each module in the chassis with a compatible revision of firmware. Use the same revisions that you used for the first redundant chassis.

Synchronize the Controllers

To synchronize the controllers in the redundant chassis pair:

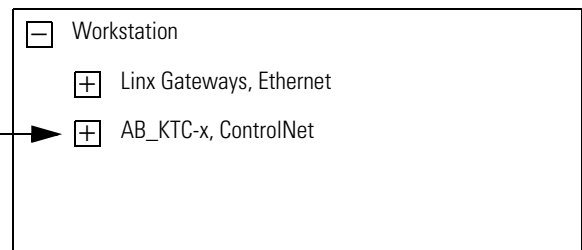
- ☐ Set the Auto-Synchronization Option to Always
- ☐ Synchronize the Controllers

Set the Auto-Synchronization Option to *Always*

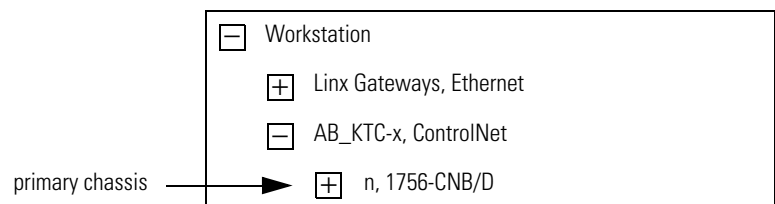
1. Open RSLinx software.
2. From the *Communications* menu, choose *RSWho*.

To expand a network one level, do one of the following:

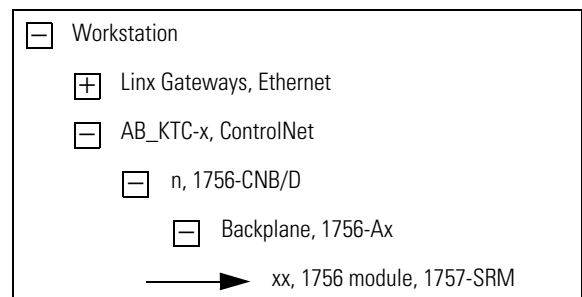
- Double-click the network.
- Select the network and press the → key.
- Click the + sign.



3. Navigate to the CNB module of the primary chassis. The primary chassis uses the node to which its rotary switches are set.



4. Expand the CNB module of the primary chassis.
5. Expand the backplane.

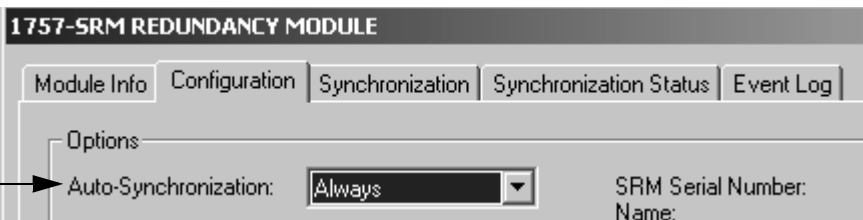


6. Right-click the 1757-SRM module and choose *Module Configuration*.

7. Set the Auto-Synchronization option = Always.

a. Click the *Configuration* tab.

b. Choose *Always*.

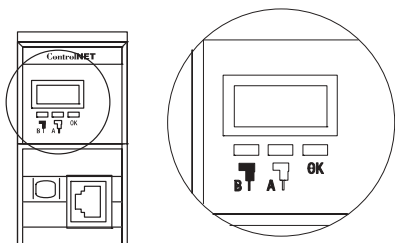


8. Choose *OK*.

Synchronize the Controllers

1. Turn on the chassis power to the partner (secondary) chassis.
2. Wait for the 1757-SRM module to complete its power-up cycle.
 - The SRM module may take 1 to 3 minutes to power-up.
 - It may also take several minutes to synchronize the secondary controller.
3. In the *primary* chassis, what do the CNB modules display?

Primary



If:	Then:	Which means:
PwQS	Primary with Synchronized (Qualified) Secondary	The redundant chassis are synchronized. Go to "Download the Project to the Primary Controller" on page 3-12.
PwDS	Primary with Disqualified Secondary	A problem exists. The redundant chassis are not synchronized. Go to "Troubleshoot a Failure to Synchronize" on page 5-3.

Download the Project to the Primary Controller

You only have to download the project to the primary controller. When the secondary controller is synchronized, the system automatically crossloads the project to the secondary controller.

IMPORTANT

If the secondary chassis becomes disqualified after you download the project, make sure:

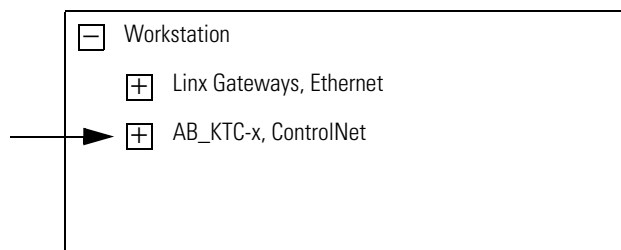
- the project is configured for a 1756-L55 ControlLogix5555 controller
- redundancy is enabled

See “Configure the Project for the Controllers” on page 4-2.

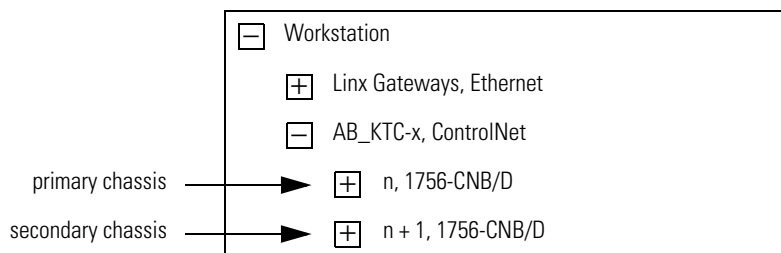
1. Open or create the RSLogix 5000™ project for the controller.
2. From the *File* menu, choose *Save*.
3. From the *Communications* menu, choose *Who Active*.

To expand a network one level, do one of the following:

- Double-click the network.
- Select the network and press the → key.
- Click the + sign.

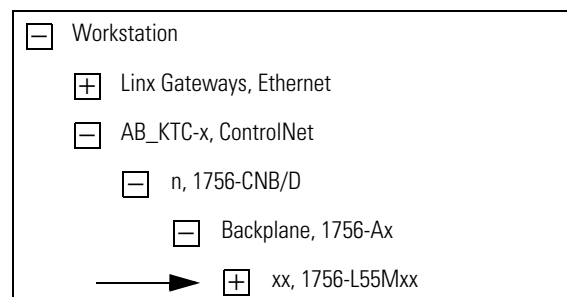


4. Navigate to the CNB module of the primary chassis. The primary chassis uses the node to which its rotary switches are set.



5. Expand the CNB module of the primary chassis.

6. Expand the backplane.



7. Select the controller and choose *Download*.

A confirmation box opens.

8. Choose *Download*.

Schedule the Networks

IMPORTANT

Before you schedule a ControlNet network, turn on the power to both redundant chassis. If you schedule a ControlNet network while the secondary chassis is off, the keeper signature of a CNB module may not match its partner, and the secondary chassis will fail to synchronize.

Use the following procedures to schedule your network:

- ☐ Schedule a New Network
- ☐ Update the Schedule of an Existing Network
- ☐ Check the Keepers
- ☐ Save the Project for Each Controller

Schedule a New Network

1. Turn on the power to each chassis.
2. Start RSNetworkx™ for ControlNet™ software.
3. From the *File* menu, choose *New*.
4. From the *Network* menu, choose *Online*.

5. Select your ControlNet network and choose *OK*.
6. Select the *Edits Enabled* check box.
7. From the *Network* menu, choose *Properties*.
8. From the *Network Parameters* tab, type or select the following parameters:

In this box:	Specify:
Network Update Time	repetitive time interval in which data is sent over the ControlNet network
Max Scheduled Address	greatest node number to use scheduled communications on the network
Max Unscheduled Address	greatest node number that you will use on the network
Media Redundancy	channels in use
Network Name	name for the network

9. choose *OK*.
10. From the *Network* menu, choose *Single Pass Browse*.
11. From the *File* menu, choose *Save*.
12. Type a name for the file that stores the network configuration, then choose *Save*.
13. Select the *Optimize and re-write Schedule for all Connections* button (default) and choose *OK*.

Update the Schedule of an Existing Network

1. Turn on the power to each chassis.
2. Start RSNetworkx for ControlNet software.
3. From the *File* menu, choose *Open*.
4. Select the file for the network and choose *Open*.
5. From the *Network* menu, choose *Online*.
6. Select the *Edits Enabled* check box.
7. From the *Network* menu, choose *Properties*.
8. From the *Network Parameters* tab, update the following parameters:

In this box:	Specify:
Max Scheduled Address	greatest node number to use scheduled communications on the network
Max Unscheduled Address	greatest node number that you will use on the network

9. choose *OK*.
10. From the *Network* menu, choose *Single Pass Browse*.
11. From the *File* menu, choose *Save*.
12. Select the *Optimize and re-write Schedule for all Connections* button (default) and choose *OK*.

Check the Keepers

On a ControlNet network, each keeper must:

- be able to take over the keeper duties if the current keeper drops off the network
- use the same configuration (signature) regardless of which keeper comes online first after a major network disturbance (cable short, system power cycle, etc.)

After you schedule your ControlNet networks:

Keeper Capable Node	Active Keeper	Valid Keeper	
offline file	N/A	N/A	
01	NO	YES	
02	YES	YES	

1. Make sure the network shows all keeper capable nodes.
2. Make sure that each node is a valid keeper.

For more information, see “Update a Keeper Signature” on page 5-4.

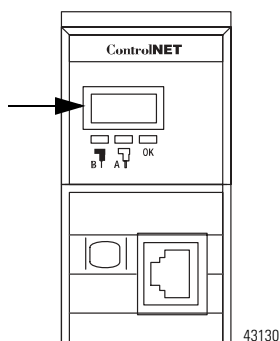
Save the Project for Each Controller

After you schedule your ControlNet networks, save the online project of each controller. This lets you download a project in the future without having to reschedule the networks.

For each controller (redundant and non-redundant) on a ControlNet network:

1. Go online to the controller.
2. Save the project.

Test the Switchover

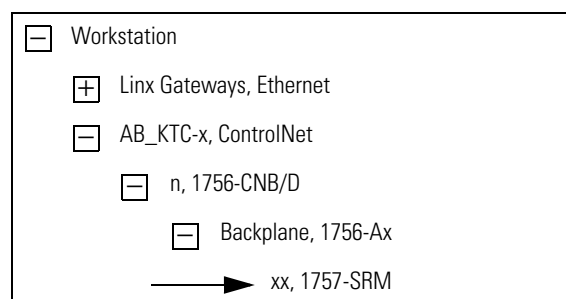


To test a switchover, use RSLinx software to manually initiate a switchover. During a switchover, the CNB modules in the new primary chassis display a sequence of status messages. Typically, the modules displays the following sequence:

<i>PwNS</i> ⇒	<i>PwDS</i> ⇒	<i>PwQg</i> ⇒	<i>PwQS</i>
primary with no secondary	primary with disqualified secondary	primary with synchronizing (qualifying) secondary	primary with synchronized (qualified) secondary

Make Sure the Auto-Synchronization Option = *Always*

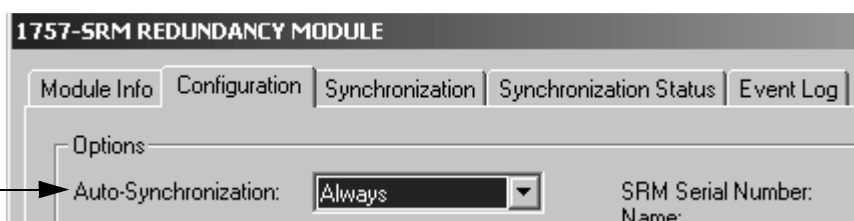
1. Display RSLinx software.
2. From the *Communications* menu, choose *RSWho*.
3. Expand the network until you see the 1757-SRM module in the primary chassis.



4. Right-click the 1757-SRM module and choose *Module Configuration*.
5. Set the Auto-Synchronization option = *Always*.

a. Click the *Configuration* tab.

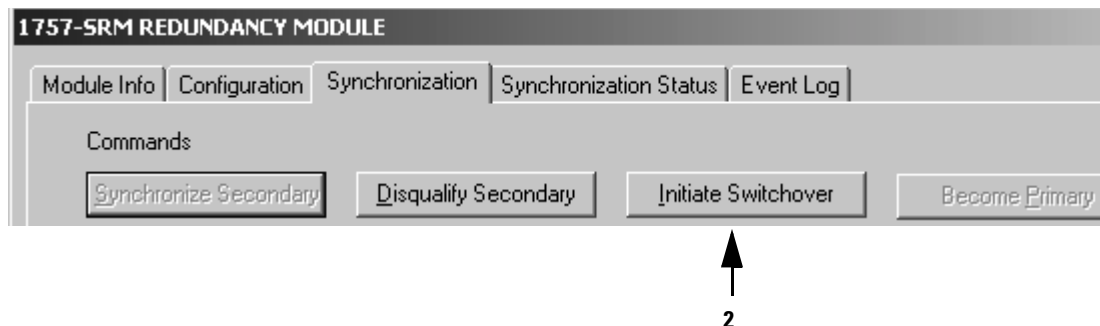
b. Choose *Always*.



6. Choose *Apply*.

Initiate a Switchover

1. Click the *Synchronization* tab.



2. Choose *Initiate Switchover* and then choose *Yes* to confirm.

Make Sure the Controllers are Synchronized

If you set the *Auto-Synchronization* option to *Always*, the SRM modules try to synchronize the controllers after a switchover.

1. To monitor the synchronization progress, click the *Synchronization Status* tab.

The screenshot shows the '1757-SRM REDUNDANCY MODULE' window with the 'Synchronization Status' tab selected. The table below shows the synchronization status for various modules.

Slot	% Complete	Module	Secondary Readiness	State	Compatibility
0	0	1756-L55	Synchronizing	Primary	Full
1	---	<empty>	---	---	---
2	---	<empty>	---	---	---
3	---	<empty>	---	---	---
4	19	1756-CNBR	Synchronizing	Primary	Full
5	---	<empty>	---	---	---
6	---	<empty>	---	---	---
7	---	<empty>	---	---	---
8	0	1757-SRM	Disqualified	Primary	Full

If the controller contains a large project, the system may spend some time synchronizing the secondary controller.

2. If the *Secondary Readiness* remains *Disqualified*, see “Troubleshoot a Failure to Synchronize” on page 5-3.

Configure and Program the Controller

When to Use this Chapter

After you have installed your system, use this chapter to configure and program the controller for redundancy.

IMPORTANT

Create and maintain only one RSLogix 5000 project for the pair of redundant controllers. When you download the project to the primary controller, the project automatically crossloads to the secondary controller.

How to Use this Chapter

To configure and program your controller, complete the following tasks:

Task:	See page:
☐ Configure the Project for the Controllers	4-2
☐ Configure Communications	4-6
☐ Estimate the Scan Time of a Program	4-9
☐ Minimize Scan Time	4-10
☐ Maintain the Integrity of Your Data During a Switchover	4-15
☐ Set the Task Watchdog Times	4-20

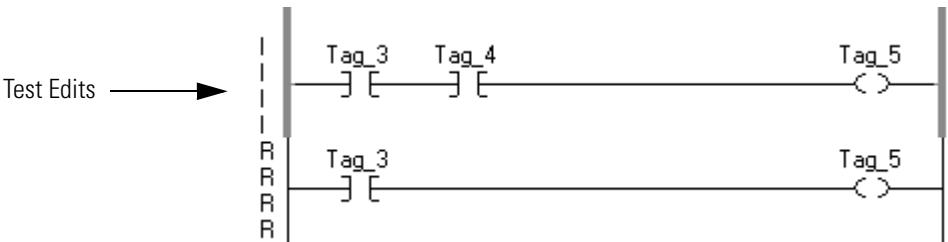
Configure the Project for the Controllers

To configure the project for your controller:

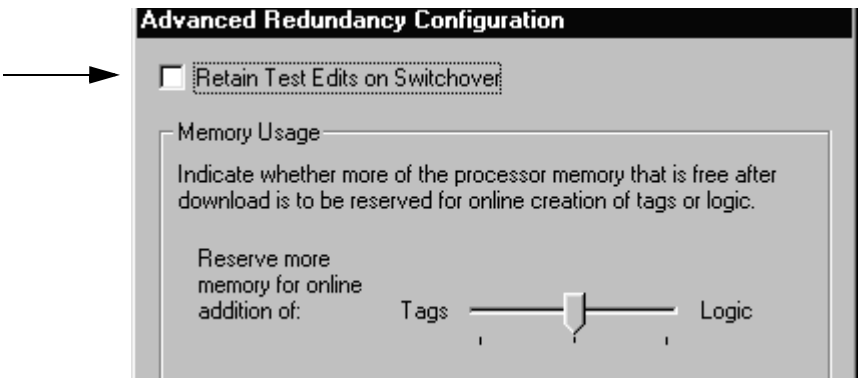
- ☐ Determine When to Retain Test Edits
- ☐ Determine How to Reserve Memory
- ☐ Configure a Controller for Redundancy

Determine When to Retain Test Edits

When you edit your logic while online with the controller, it is possible for those edits to fault the controller and cause a switchover.



If the test edits fault the primary controller, it is likely they will fault the secondary controller as well. To prevent this from occurring, any test edits are deactivated (untested) during a switchover. As an option, you can keep the edits active after a switchover:



If you want to:	Then:
prevent an incorrect online edit from faulting both the primary and secondary controller	Do not retain test edits (default setting).
keep test edits active during a switchover (at the risk of faulting both controllers)	Retain test edits.

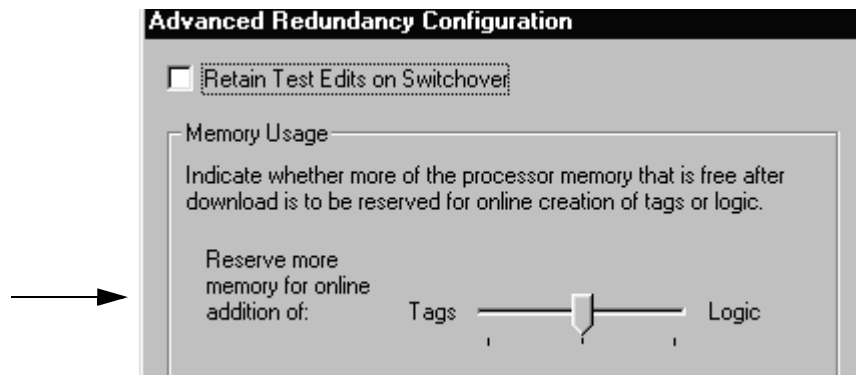
Determine How to Reserve Memory

When the secondary controller receives crossload data, it first buffers tag data in a quarantine section of memory. When it has all of the data and knows it is valid, it moves the data into the main memory area. That is why a redundant controller requires twice as much memory for tags as a non-redundant controller.

The controller sets up the quarantine area at the time of download:

- The controller divides its memory into two sections:
 - tags, including a quarantine area
 - logic
- The controller also divides its unused memory. It reserves a specific amount for tags and the rest for logic.

You configure how to reserve unused memory between tags and logic. You do this offline only, before you download the project.



If you plan to:	Then:
<i>while online</i> , create roughly the same amount of new tags and new logic	Leave the default setting.
<i>while online</i> , create a relatively large amount of new tags but a much smaller amount of new logic	Drag to slider toward <i>Tags</i> .
<i>while online</i> , create a relatively large amount of new logic but a much smaller amount of new tags	Drag to slider toward <i>Logic</i> .

Configure a Controller for Redundancy

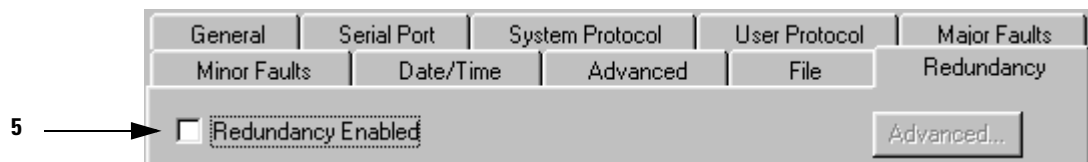
1. Open or create the RSLogix 5000™ project.



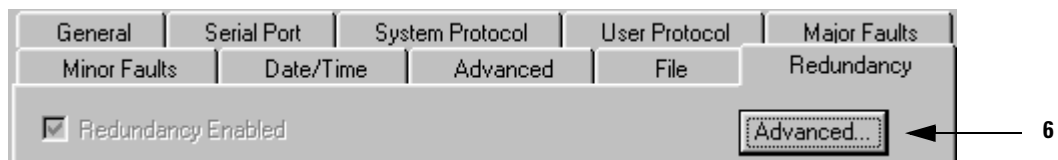
2. On the Online toolbar, click the controller button.
3. Does the *General* tab show that the controller type is a 1756-L55 controller?

If:	Then:
No	A. Click the <i>Change Type</i> button. B. Select a 1756-L55 controller. C. Choose <i>OK</i>.
Yes	Go to step 4.

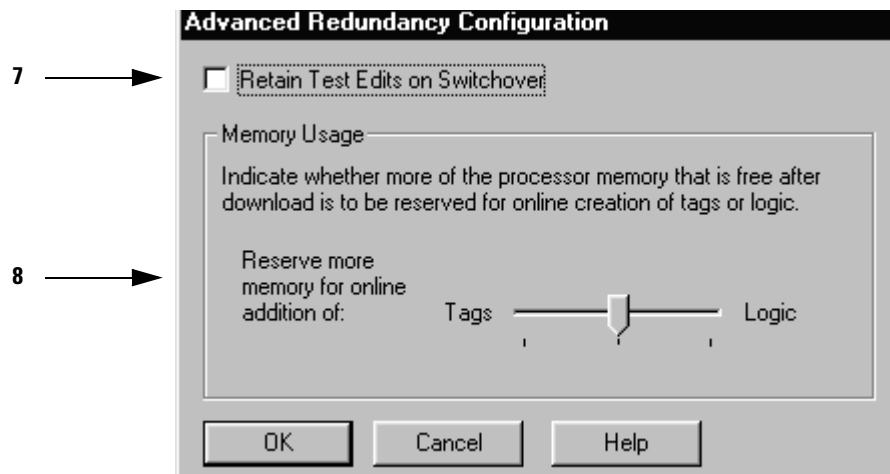
4. Click the *Redundancy* tab.



5. Select the *Redundancy Enabled* check box.



6. Click the *Advanced* button.



7. We recommend that you leave this check box cleared (unchecked). This prevents an incorrect online edit from faulting both the primary and secondary controller.

If you want any test edits to remain active during a switchover (at the risk of faulting both controllers), then check this check box.

8. For online editing, choose how you want to reserve any free memory.

9. Choose

10. To close the Controller Properties dialog box, choose

Configure Communications

A redundant system requires some specific configuration choices for successful communications. Use this section for guidance on how to configure the following elements for redundancy:

- ☐ Configure I/O
- ☐ Configure Produced Tags
- ☐ Configure Message (MSG) Instructions
- ☐ Configure Tags for an HMI

Configure I/O

IMPORTANT

For each module in your system, make sure that the requested packet interval (RPI) is less than or equal to 375 milliseconds. If you use a larger RPI, the controller could lose its connection with the module during a switchover. This could cause outputs to change state.

For any outputs that require a bumpless switchover:

- Put those outputs in the highest priority task.
- Configure only that task at the highest priority.

Configure Produced Tags

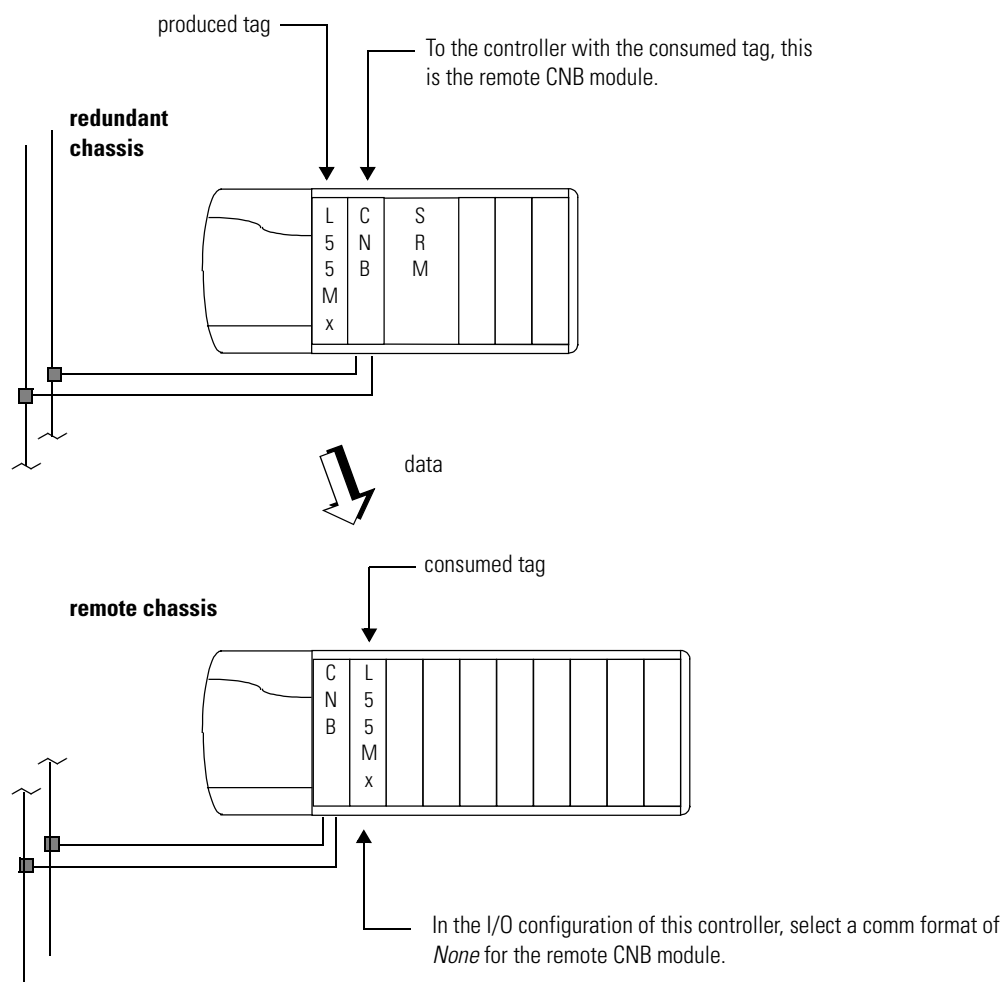
IMPORTANT

During a switchover, the connection for tags that are consumed *from* a redundant controller may time out.

- The data *does not* update.
- The logic acts on the last data that it received.

After the switchover, the connection reestablishes and the data begins to update again.

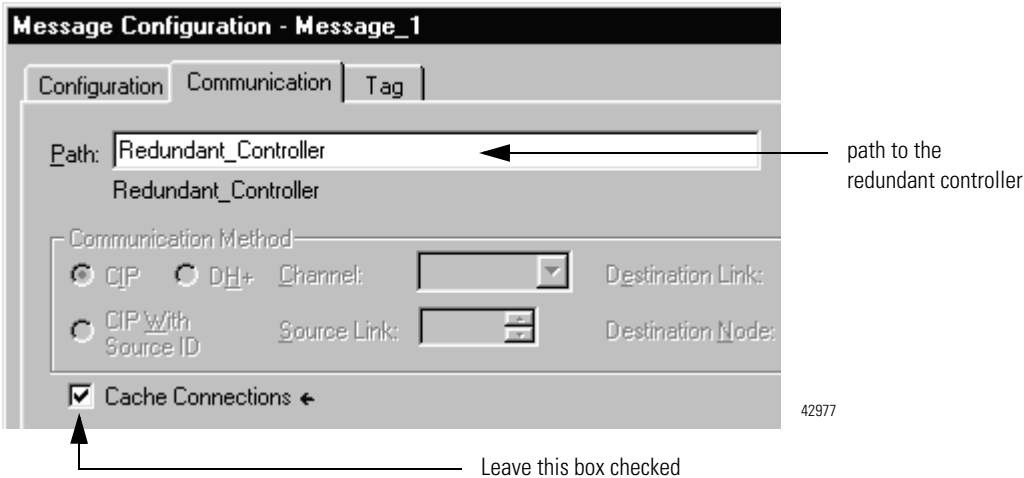
If you want a controller in another chassis to consume a tag from the redundant controller, use a comm format of *None*. In the I/O configuration of the consuming controller, select a comm format of *None* for the remote CNB module (the CNB that is physically in the redundant chassis).



Configure Message (MSG) Instructions

If the MSG instruction is:	Then:
from a redundant controller	In a redundant controller, any MSG instruction that is in progress during a switchover experiences an error. (The ER bit of the instruction turns on.) After the switchover, normal communication resumes.
to a redundant controller	For any MSG instruction from a controller in another chassis to a redundant controller, cache the connection:

Properties of the Message to the Redundant Controller



Configure Tags for an HMI

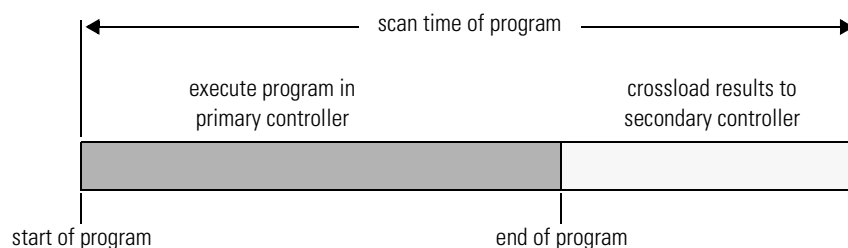
If you plan to monitor tags directly in the secondary controller (not typical), monitor from no more than 3 devices through a CNB module.

You can monitor tags in a secondary controller *only* via:

- RSLogix 5000 software
- Any method that does *not* try to create OPC optimized packets. Only a primary controller can create an OPC optimized packet.

Estimate the Scan Time of a Program

At the end of each program, the primary controller crossloads fresh data to the secondary controller, as described in Chapter 1. This keeps the secondary up-to-date and ready to take over control but also increases the scan time when compared to a non-redundant system.



The length of time for the crossload depends on the amount of data that has to be crossloaded. Crossloading also requires a small amount of overhead time to tell the secondary controller which program the primary controller is executing.

The primary controller crossloads any tag to which an instruction wrote a value (even the same value) since the last crossload. To estimate the time for the crossload, use the following formula:

Crossload time = (0.002 to 0.003 ms * *DINTs*) + 0.3 to 0.5 ms of overhead

where:

DINTs is the amount of tag data to be crossloaded, measured in 4-byte words.

In addition, a task time that is less than the crossload time could flood the SRM module with data. When this occurs, the SRM module pauses for approximately 5 ms to clear the overflow buffer. This adds 5 ms to the scan time.

To determine the amount of crossload data, use a GSV instruction to access the REDUNDANCY object (only available for a controller that is configured for redundancy). For more information, see “Get System Values” on page 5-20.

Minimize Scan Time

To minimize the scan time of your project, follow these guidelines:

- ☐ Use a Few Large Programs
- ☐ Minimize the Use of SINT or INT tags
- ☐ Use Arrays and User-Defined Data Types
- ☐ Pack Data into Arrays
- ☐ Execute Instructions Only When Required

Use a Few Large Programs

Since the primary controller pauses its execution at the end of every program to crossload data, combine your logic into a few relatively large programs instead of many smaller programs.

- A fewer number of programs requires fewer crossloads.
- Larger programs pack more data into each crossload since more logic will have executed before the crossload.

Divide each program into whatever number of routines makes the most sense for your logic. The number of routines have no effect on the frequency of crossloads.

Minimize the Use of SINT or INT tags

Regardless of whether or not it is configured for redundancy, a ControlLogix controller typically compares or manipulates values as 32-bit values (DINTs or REALs).

- The controller typically converts a SINT or INT value to a DINT or REAL value before it uses the value.
- If the destination is a SINT or INT tag, the controller typically converts the value back to a SINT or INT value.
- The conversion to or from SINTs or INTs occurs automatically with no extra programming. But it takes extra execution time and memory.

To increase the efficiency of your logic, minimize the use of SINT or INT data types.

Use Arrays and User-Defined Data Types

To update the secondary controller, the primary controller divides its memory into blocks of 256 bytes. Anytime an instruction writes a value, the primary controller crossloads the entire block that contained the value. For example, if your logic writes only 1 BOOL value to a block, the controller crossloads the entire block (256 bytes).

To minimize scan time, organize your data into arrays and user-defined data types (structures) whenever possible. Arrays and structures provide these advantages:

- Data is more compact. This lets the primary controller crossload it more quickly.
- Related data is grouped together.
 - Related data is likely to change at the same time.
 - Since the controller crossloads data in 256 byte blocks, fewer blocks may be required than if the same amount of data was spread across many individual tags.

To create arrays and user-defined data types, see the *Logix5000 Controllers Common Procedures*, publication 1756-PM001.

Pack Data into Arrays

The minimum memory allocation for a tag is 4 bytes. When you create a tag that stores data that requires less than 4 bytes, the controller allocates 4 bytes, but the data only fills the part it needs.

Data type	Bits								
	31		16		15	8	7	1	0
Bool	not used								0 or 1
Sint	not used						-128 to +127		
Int	not used				-32,768 to +32,767				
Dint	-2,147,483,648 to +2,147,483,647								
Real	-3.40282347E ³⁸ to -1.17549435E ⁻³⁸ (negative values) 0 1.17549435E ⁻³⁸ to 3.40282347E ³⁸ (positive values)								

User-defined data types and arrays pack smaller data types into 32-bit words. For example:

- If you create 32 individual BOOL tags, the controller allocates 128 bytes for the data (32 BOOL tags x 4 bytes/tag = 128 bytes).
- If you create an array of 32 BOOLs, the controller packs them into a 4-byte chunk of memory.

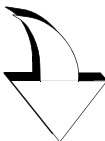
Bits	
31	0
Bool_Array[31]...	Bool_Array[0]

Arrays provide the greatest advantage with BOOL tags. If you have individual SINT, INT, DINT, or REAL tags, also use arrays to pack those tags as efficiently as possible.

One simple way to pack existing data into arrays is to convert the tags to alias tags for elements of an array, as shown below:

BOOLs as individual tags

Tag Name ▾	Alias For	Base Tag	Type
Bool_Tag_1			BOOL
Bool_Tag_2			BOOL
Bool_Tag_3			BOOL



Same BOOLs but packed into an array

1. →

Tag Name ▾	Alias For	Base Tag	Type
Bool_Array			BOOL[32]
Bool_Tag_1	Bool_Array[0]	Bool_Array[0]	BOOL
Bool_Tag_2	Bool_Array[1]	Bool_Array[1]	BOOL
Bool_Tag_3	Bool_Array[2]	Bool_Array[2]	BOOL

2. ↑

3. →

Bool_Tag_1
<Bool_Array[0]>

Bool_Tag_2
<Bool_Array[1]>

1. Create a BOOL array.
 2. Convert your BOOL tags to aliases for elements within the BOOL array.
 3. In your logic, continue to reference the existing tag names.
- The system crossloads the Base tag, which in this example is the array of BOOLs. The array is more compact than the individual tags.

Execute Instructions Only When Required

Anytime an instruction writes a value to a tag, even if it is the same value, the primary controller crossloads the value to the secondary controller:

- Many instructions write a value to a tag whenever they execute. For example, instructions such as OTL, OTU, and many instructions with Destination operands write a value each time the rung-condition-in is true.
- Whenever an instruction writes a value, the controller marks the value for the next crossload. This occurs even if the instruction wrote the same value that was previously in the tag.

To minimize scan time, execute instructions only when required, if possible. Use techniques such as:

- Make a rung false when you don't need to execute its instructions.
- Divide your logic into subroutines and execute each subroutine only when required.

This reduces the amount of crossload data, which reduces scan time.

EXAMPLE

Execute an instruction only when required

Each time the following rung executes, the ADD instruction writes the sum of *Tag_1* + *Tag_2* to *Dest_Tag*.



Regardless of whether the value in *Dest_Tag* changed from the last scan, the controller marks *Dest_Tag* to be included in the next crossload. If your application needs to recalculate *Dest_Tag* only when it gets new data, you could modify the rung as follows:

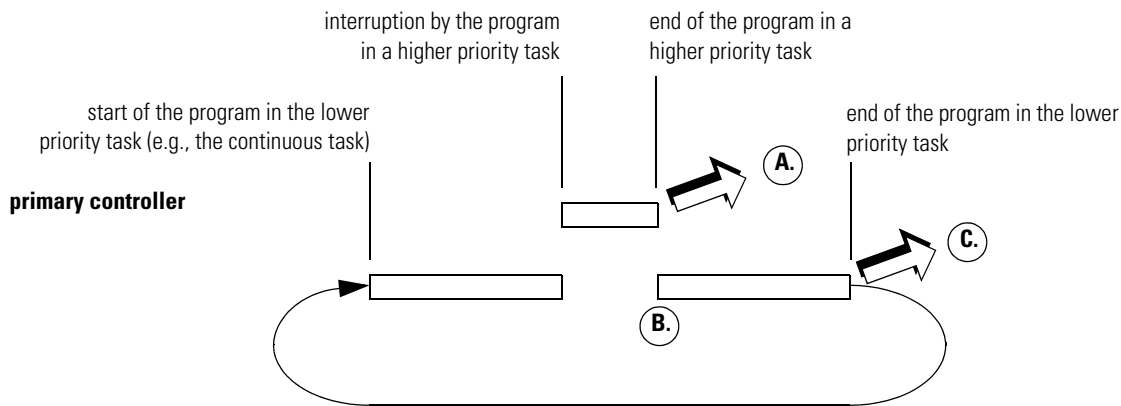


The ADD instruction now executes only when the controller gets new data (*New_Data* = on). And *Dest_Tag* crossloads only when the ADD instruction produces a new value.

Maintain the Integrity of Your Data During a Switchover

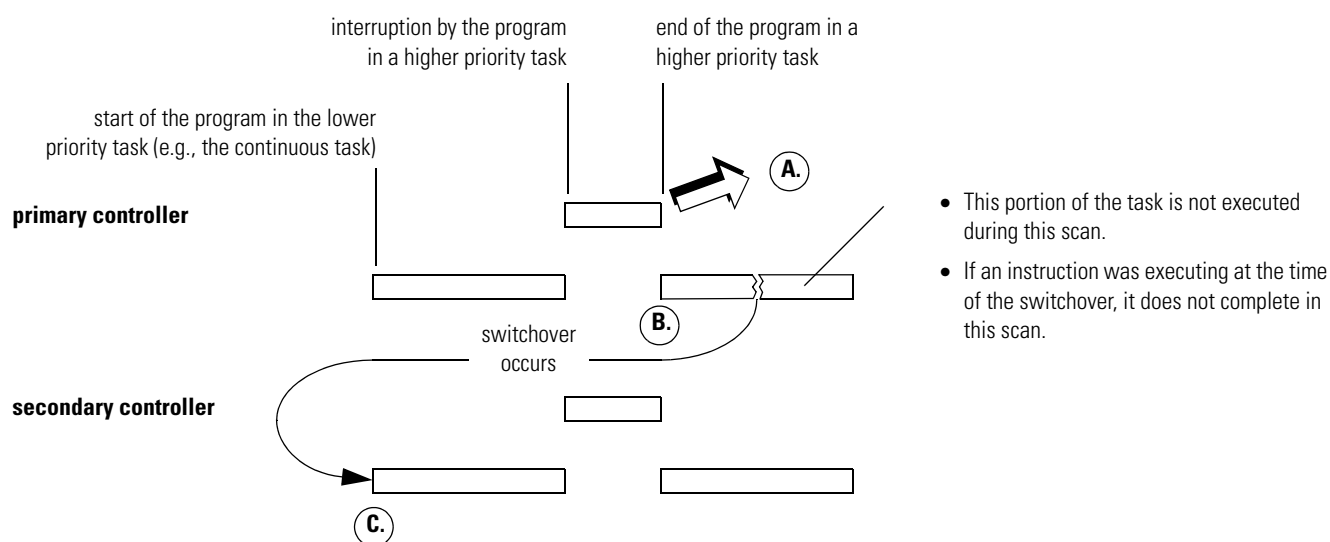
The redundancy system guarantees a bumpless switchover for any logic in the highest priority task. In some cases, logic in lower priority tasks may experience an upset when a switchover occurs. This has to do with how data crossloads from the primary controller to the secondary controller.

As the primary controller executes its logic, it updates the secondary controller at the end of every program.



- A.** The following data is sent to the secondary controller:
 - data from the program in the higher priority task
 - data from the first part of the program in the lower priority task
- B.** Execution returns to the program in the lower priority task.
- C.** Data from the second part of the program in the lower priority task is sent to the secondary controller.

When a switchover interrupts the execution of the primary controller, the secondary controller re-executes an interrupted program from the beginning of the program.



A. The following data is sent to the secondary controller:

- data from the program in the higher priority task
- data from the first part of the program in the lower priority task

B. Execution returns to the program in the lower priority task.

C. The secondary controller:

- starts the scan at the beginning of the program that was in progress in the primary controller at the time of the switchover
- uses the data from the last update

In this example, the secondary controller starts the scan with an image of the data as it was *during* the last scan of the primary controller.

To find places in your logic that might be susceptible to an upset during a switchover:

- ☐ Look for Array Shift Instructions
- ☐ Look for Logic That is Scan-Dependant
- ☐ Take Preventative Actions

Look for Array Shift Instructions

The following instructions might corrupt your data during a switchover:

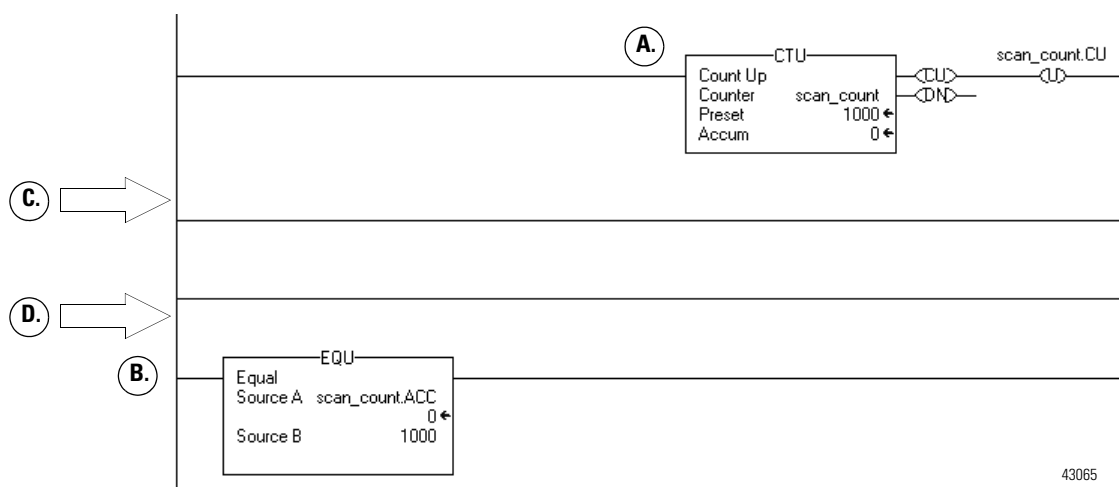
- BSL
- BSR
- FFU

Because these instructions shift data within an array, an interruption by a higher priority task and a subsequent switchover leaves the data with an incomplete shift:

- If a higher priority task interrupts one of these instructions, the partially-shifted array values are sent to the secondary controller.
- If a switchover occurs before the instruction completes its execution, data remains only partially shifted.
- The secondary controller starts its execution at the beginning of the program, When it reaches the instruction, it shifts the data again.

Look for Logic That is Scan-Dependant

A rung that must read the output of another rung during the same scan might miss a scan during a switchover. For example:



43065

- A.** The CTU instruction counts each scan.
- B.** The EQU instruction uses the count of each scan (*scan_count.ACC*).
- C.** If a higher priority task interrupts the logic, the value of *scan_count.ACC* is sent to the secondary controller at the end of the program in the higher priority task.
- D.** If a switchover occurs before the EQU instruction, the secondary controller starts its execution at the beginning of the program. The EQU instruction misses the last value of *scan_count.ACC*.

Take Preventative Actions

If you find a place in your logic that might be susceptible to an upset during a switchover, take one of the following preventative actions:

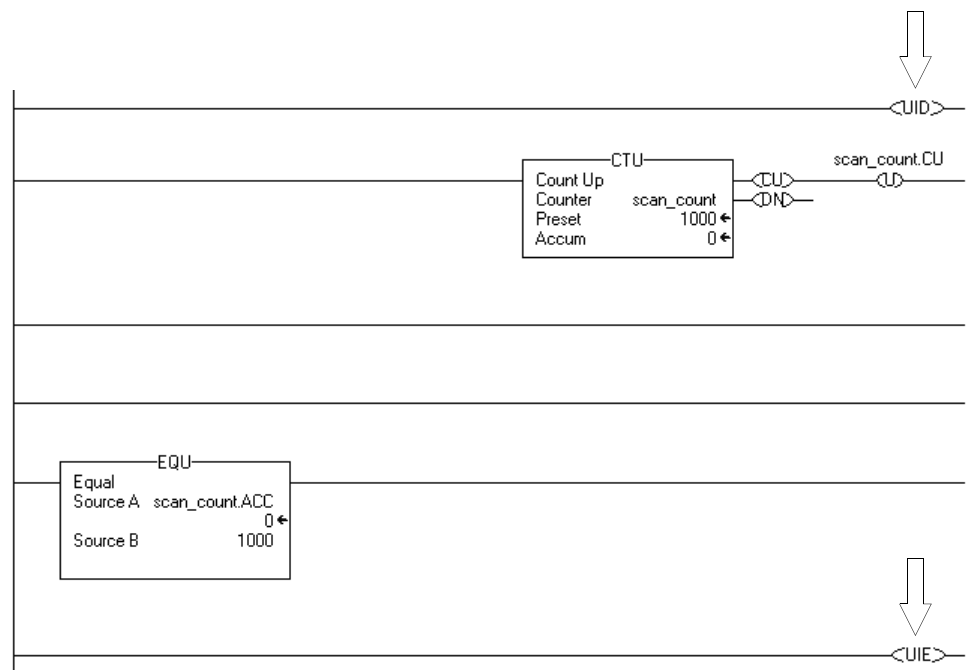
1. Place Susceptible Logic in the Highest Priority Task
2. If the logic must remain in a lower priority task, take one of the following actions:
 - Use UID and UIE Instruction Pairs
 - Buffer Critical Data

Place Susceptible Logic in the Highest Priority Task

- This prevents the controller from sending any data to the secondary controller until the program finishes.
- If a switchover occurs during the program, the secondary controller repeats the scan using the same starting data.

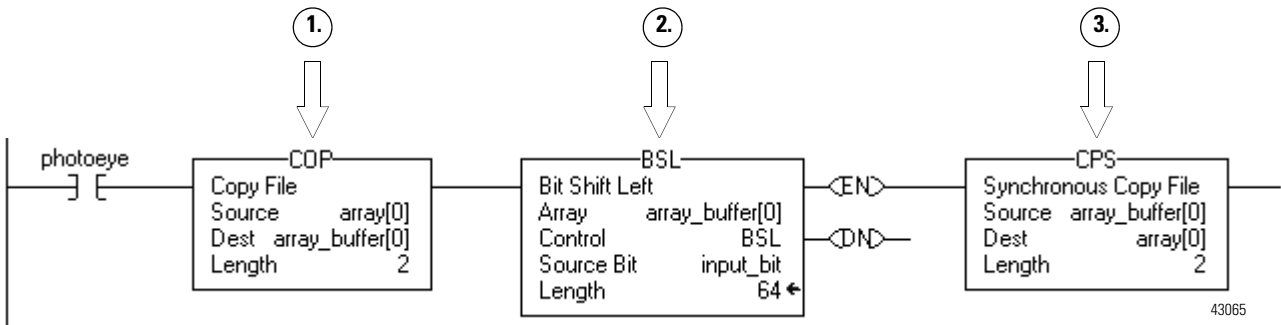
Use UID and UIE Instruction Pairs

Bound critical rungs with UID and UIE instruction pairs. This prevents the higher priority task from interrupting the scan-dependent logic, as shown below:



Buffer Critical Data

The following example shows the use of a buffer together with a BSL instruction.



1. The COP instruction moves the data into a buffer array.
2. The BSL instruction uses the data in the buffer. If a switchover occurs, the source data (*array* tag) remains unaffected.
3. The CPS instruction updates *array* tag. Since higher priority tasks cannot interrupt a CPS instruction, the instruction keeps the integrity of the data.

Set the Task Watchdog Times

A redundant controller requires longer watchdog times than a non-redundant controller. To avoid a major fault (type 6, code 1) due to a watchdog time-out after a switchover, complete the following actions:

- ☐ Estimate a Watchdog Time
- ☐ Set the Watchdog Time for a Task
- ☐ Determine the Scan Time of a Task

Estimate a Watchdog Time

A redundant controller requires longer watchdog times than a non-redundant controller:

- After a switchover, the secondary controller starts the scan at the beginning of the program that was in progress in the primary controller at the time of the switchover.
- The watchdog timer for the task that contains the program, however, is not reset.
- If the watchdog time does not include time for a complete rescan of the program, a major fault could occur.

To estimate watchdog time for a task, use the following formula:

$$\text{Watchdog time} \geq (2 * \text{maximum\_scan\_time}) + 100 \text{ ms}$$

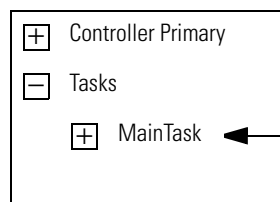
where:

Maximum_scan_time is the maximum scan time for the entire task when the secondary controller is synchronized.

Once you enter a watchdog time, use the actual scan time for a task to revise the watchdog time, if required.

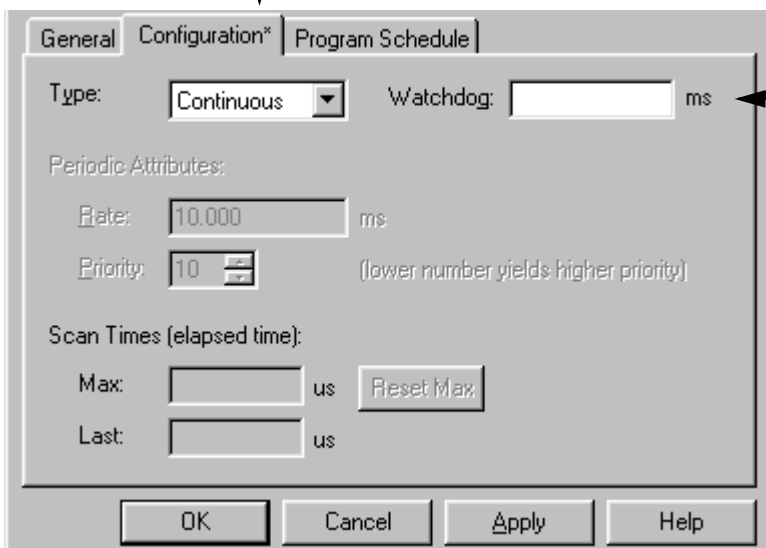
Set the Watchdog Time for a Task

To set the watchdog time for a task:



1. Right-click the task and choose *Properties*.

2. Click the *Configuration* tab.

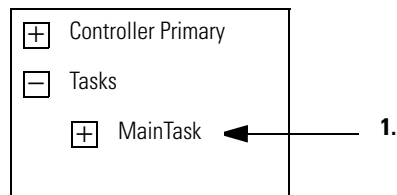


3. Type the watchdog time.

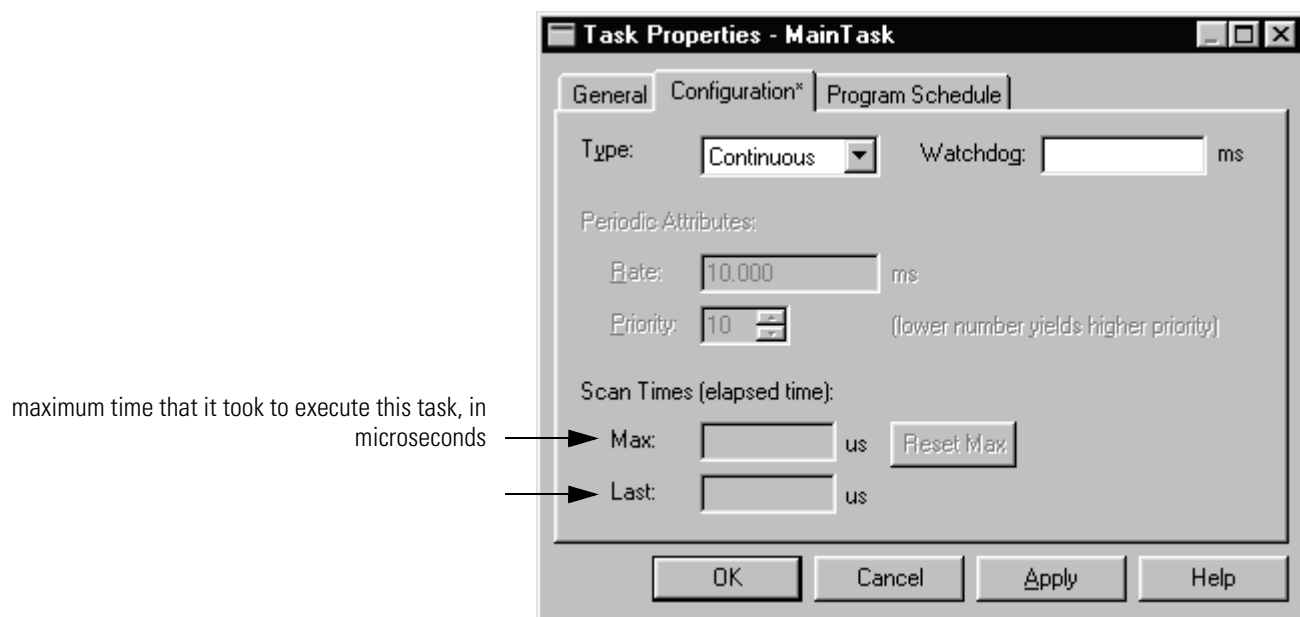
4. Choose 

Determine the Scan Time of a Task

To get the actual scan times for a task:



1. Right-click the task and choose *Properties*.
2. Click the *Configuration* tab.



43080

3. To close the dialog box, choose 

Maintain and Troubleshoot the System

When to Use this Chapter

This chapter provides a variety of procedures to assist as you commission and operate your redundancy system.

How to Use this Chapter

If you want to:	Then see this section:	Which starts on page:
diagnose the cause of an unplanned switchover	Determine the Cause of a Switchover	5-2
determine why the secondary controller fails to synchronize	Troubleshoot a Failure to Synchronize	5-3
initiate the synchronization process	Manually Synchronize the Controllers	5-6
- determine why it takes a very long time to synchronize the secondary controller - determine why communication with your HMIs is very slow	Optimize Communication	5-7
- determine the CPU usage of a CNB module - reduce the CPU usage of a CNB module	Adjust CNB Usage	5-11
export specific events from the SRM event log and view them in a Microsoft® Excel spreadsheet:	Export the SRM Event Log to Microsoft® Excel	5-15
change when the 1757-SRM modules try to synchronize the controllers	Configure the Auto-Synchronization Option	5-18
use ladder logic to get system or status information about your redundancy system	Get System Values	5-20
use ladder logic to initiate a redundancy action, such as synchronize the secondary controller	Send a Message to an SRM Module	5-24
- store a project to the nonvolatile memory of a controller in a redundant system - load a project into the controller from the nonvolatile memory of the controller	Store or Load a Project Using Nonvolatile Memory	5-30
change the revision of a module while minimizing the time your system is off	Update a Module	5-31

Determine the Cause of a Switchover

If an unplanned switchover occurs, use the following tables to determine the cause of the switchover.

In the primary chassis, what does the CNB module display?

Front Panel:	If:	Then:
Look here. → ControlNET BT AT OK 43130	PwNS	Go to Table 5.1
	PwDS	Go to Table 5.2

Table 5.1 If a CNB module displays PwNS, use this table to troubleshoot the secondary chassis.

If the secondary chassis:	And each primary CNB module:	And a secondary CNB module has a:	Then:
has power	has a partner module in the secondary chassis	Red OK LED	Replace the CNB module.
		Green OK LED	Check the 1756-SRC cable for a proper connection.
	does not have a partner module in the secondary chassis	→	Install a CNB module.
does not have power		→	Restore the power.

Table 5.2 If a CNB module displays PwDS, use this table to troubleshoot the secondary chassis.

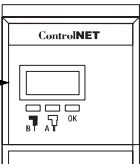
If the SRM module has a:	And a secondary CNB module:	And a secondary controller has a:	Then:
Green OK LED	does not display <i>NET ERR</i>	Flashing Red OK LED	Clear the major fault of the controller.
		Solid Red OK LED	1. Cycle the power to the chassis. 2. If the OK LED remains solid red, replace the controller and flash the controller with the appropriate revision of firmware.
	displays <i>NET ERR</i>	→	Check all ControlNet taps, connectors, and terminators for proper connections.
Red OK LED	→		1. Cycle the power to the chassis. 2. If the OK LED of the SRM module remains solid red, contact your Rockwell Automation representative or local distributor.

Troubleshoot a Failure to Synchronize

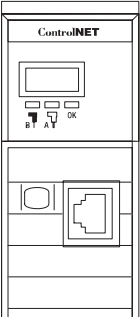
IMPORTANT

- If the steps in this section *do not* correct the situation, check the usage of the CNB modules. See “Adjust CNB Usage” on page 5-11.
- After you correct the situation, manually synchronize the controllers. See “Manually Synchronize the Controllers” on page 5-6.

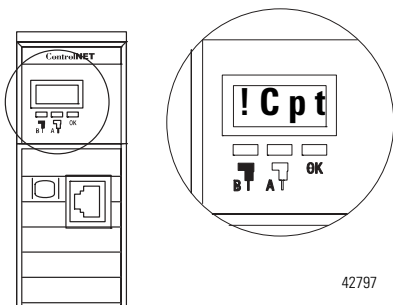
To determine if a pair of redundant chassis are synchronized, look at the 1756-CNB/D or -CNBR/D modules in the *primary* chassis:

Front panel:	If:	Then:	Which means:
Primary CNB Look here. → 	PwQS	Primary with Synchronized (Qualified) Secondary	The redundant chassis are synchronized.
	PwDS	Primary with Disqualified Secondary	A problem exists. The redundant chassis are not synchronized.
	PwNS	Primary with No Secondary	

If the chassis fail to synchronize, look at the 1756-CNB/D or -CNBR/D modules in the secondary chassis.

Front panel:	If the display shows:	Then:	So check the following:
Secondary CNB 	!Cpt	The CNB modules in the primary and secondary chassis do not match in some way.	1. All CNB modules in each redundant chassis are series D modules. 2. Each CNB module has a partner in the same slot in the other redundant chassis. 3. Each pair of CNB modules (one in each chassis) is set to the same node address. 4. All CNB modules in each redundant chassis are valid keepers. See “Update a Keeper Signature” on page 5-4.
	CMPT	Some module other than a CNB module does not match between the primary and secondary chassis.	1. Each module has a partner in the same slot in the other redundant chassis. 2. Each pair of controllers (one in each chassis) has the same memory board (e.g., 1756-L55M14). 3. Each module contains compatible firmware. 4. The RSLogix 5000 project is configured for a 1756-L55 ControlLogix5555 controller and redundancy is enabled. See “Configure the Project for the Controllers” on page 4-2. 5. The Module Configuration window for the 1757-SRM module does not list any reasons for the failure to synchronize. See “Check the Recent Synchronization Attempts” on page 5-5.
	DUPL NODE	More than one device on your ControlNet network is using the same node number.	1. No other device on the ControlNet network is set to the address of the CNB modules <i>plus one</i>. For example, if the CNB modules are set to 3, no other device should be set to 4. 2. The 1757-SRCx cable is connected to both SRM modules.
	NET ERR	The ControlNet media is not completely connected.	All ControlNet taps, connectors, and terminators are connected.

Secondary



Update a Keeper Signature

If the secondary chassis fails to synchronize, and its CNB module displays *!Cpt*, the keeper signature of a CNB module may not match its partner. This occurs if you schedule the ControlNet network while the secondary chassis is off or if the CNB module was previously configured in a different network.

1. Start RSNetWorx for ControlNet software.
2. Has this network been scheduled before?

If:	Then:
No	A. From the <i>File</i> menu, select <i>New</i> . B. From the <i>Network</i> menu, select <i>Online</i> . C. Select your ControlNet network and choose <i>OK</i> .
Yes	A. From the <i>File</i> menu, select <i>Open</i> . B. Select the file for the network and choose <i>Open</i> . C. From the <i>Network</i> menu, select <i>Online</i> .

3. From the *Network* menu, choose *Keeper Status*.

4.			5.	
↓			↓	
Keeper Capable Node	Active Keeper	Valid Keeper		
offline file	N/A	N/A		
01	NO	NO		
02	YES	YES		

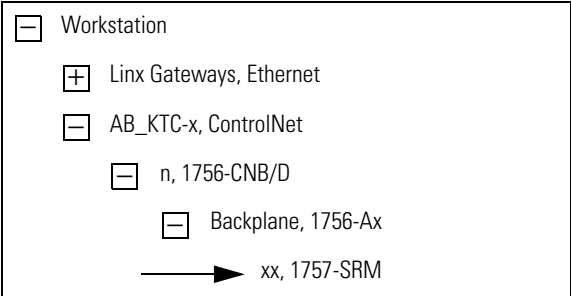
4. Make sure the list contains all keeper capable nodes.
5. Make sure that each node has a valid keeper signature.

If the Valid Keeper column shows:	Then:
YES	The node has a valid keeper signature.
NO	Select the node and choose <i>Update Keeper</i> .

6. Choose *Close*.

Check the Recent Synchronization Attempts

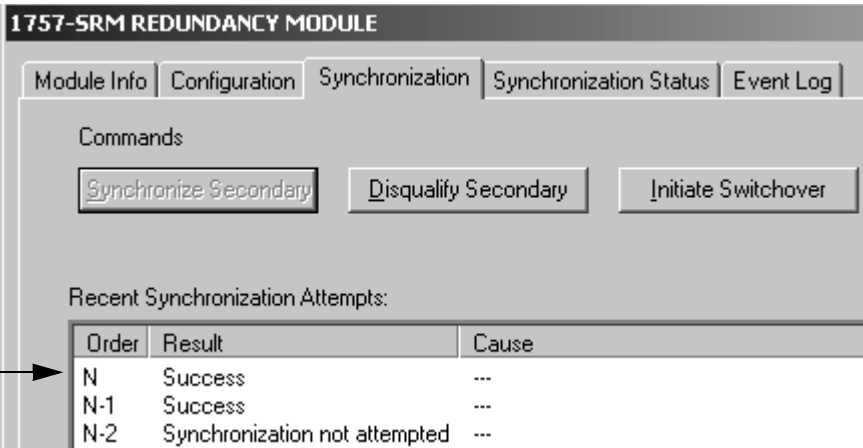
1. Display RSLinx software.
2. From the *Communications* menu, choose *RSWho*.
3. Expand the network until you see the 1757-SRM module in the primary chassis.



4. Right-click the 1757-SRM module and choose *Module Configuration*.
5. Check the *Synchronization* tab

a. Click the *Synchronization* tab.

b. Look here. →



If the Result column shows:	Then synchronization failed for this reason:	So take this corrective action:
Edit Session in Progress	Synchronization failed for any of these reasons: • Another workstation is editing the project in the controller. • The project contains test edits. • The <i>Nonvolatile Memory Load/Store</i> dialog box of the controller is open.	Either: • Stop the edit session. • Untest the edits. • Close the <i>Nonvolatile Memory Load/Store</i> dialog box.

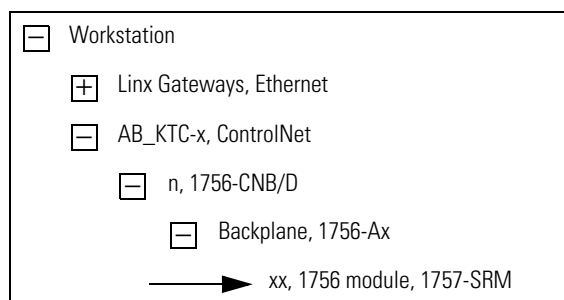
Manually Synchronize the Controllers

After a switchover, you may have to manually synchronize the controllers because either:

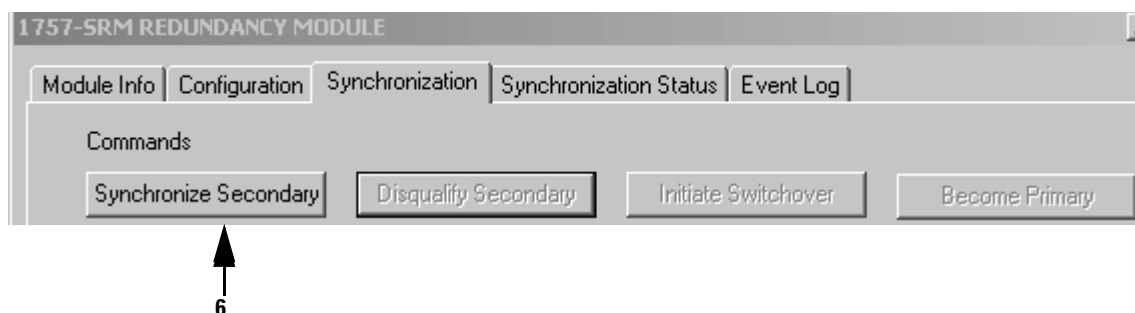
- The *Auto-Synchronization* option is NOT set to *Always*.
- The controllers failed to synchronize.

To manually synchronize the controllers:

1. Display RSLinx software.
2. From the *Communications* menu, choose *RSWho*.
3. Expand the network until you see the 1757-SRM module in the primary chassis.



4. Right-click the 1757-SRM module and select *Module Configuration*.
5. Click the *Synchronization* tab.



6. Choose *Synchronize Secondary* and then choose *Yes* to confirm.
7. Choose *OK*.

8. In the primary chassis, what do the CNB modules display?

Front Panel:	If you see:	Which means:	Then:
43130	PwQg	Primary with Synchronizing (Qualifying) Secondary	- Synchronization is in progress. - Continue waiting. It may take several minutes to synchronize the secondary controller.
	PwQS	Primary with Synchronized (Qualified) Secondary	- The secondary controller is synchronized. - Skip the remaining steps in this section.
	PwDS	Primary with Disqualified Secondary	- The secondary controller is <i>not</i> synchronized. - Go to step 9.

9. Cycle power to the secondary chassis.

10. If the CNB module in the primary chassis fails to display *PwQS*, see “Troubleshoot a Failure to Synchronize” on page 5-3.

Optimize Communication

If it takes too long to synchronize the secondary chassis or update your HMI, there may not be enough controller time for unscheduled communication. In general, unscheduled communication is any type of communication that you *do not* configure through the I/O configuration folder of the controller:

This type of communication:	Is:
update I/O data (not including block-transfers)	scheduled communication
produce or consume tags	
communicate with programming devices (e.g., RSLogix 5000 software)	unscheduled communication
communicate with HMI devices	
execute Message (MSG) instructions, including block-transfers	
respond to messages from other controllers	
synchronize the secondary controller of a redundant system	
re-establish and monitor I/O connections (such as Removal and Insertion Under Power conditions); this <i>does not</i> include normal I/O updates that occur during the execution of logic.	bridge communications from the serial port of the controller to other ControlLogix devices via the ControlLogix backplane
bridge communications from the serial port of the controller to other ControlLogix devices via the ControlLogix backplane	

To improve the speed of unscheduled communication:

If your RSLogix 5000 project contains:	Then:	See page:
only a continuous task and no other tasks (This is the default task configuration.)	Choose a Greater System Overhead Time Slice	5-8
more than one task (i.e., at least 1 periodic task)	Make All Your Tasks Periodic	5-10

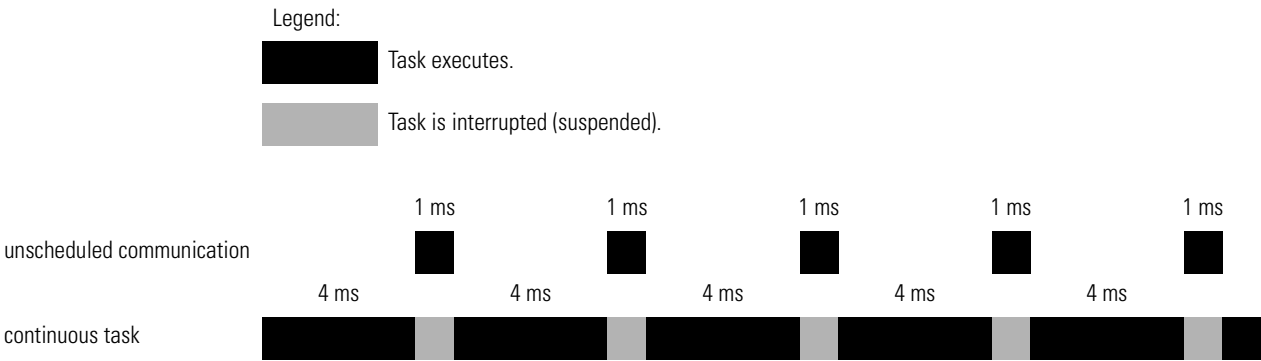
Choose a Greater System Overhead Time Slice

The system overhead time slice specifies the percentage of time (excluding the time for periodic tasks) that the controller devotes to unscheduled communication. The controller performs unscheduled communication for up to 1 ms at a time and then resumes the continuous task.

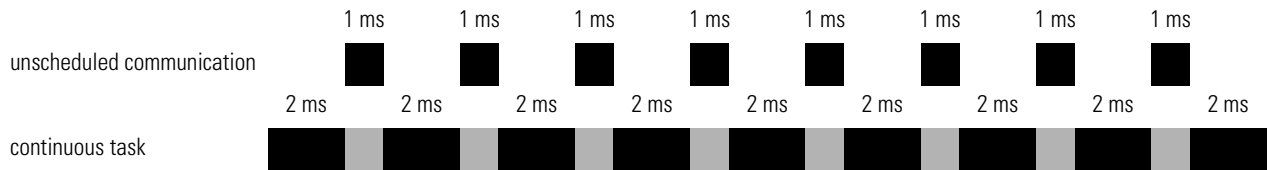
The following table shows the ratio between the continuous task and unscheduled communication at various system overhead time slices:

At this time slice:	The continuous tasks runs for:	And unscheduled communication occurs for up to:
10%	9 ms	1 ms
20%	4 ms	1 ms
33%	2 ms	1 ms
50%	1 ms	1 ms

At a system overhead time slice of 20 % (default), unscheduled communication occurs every 4 ms of continuous task time for 1 ms.

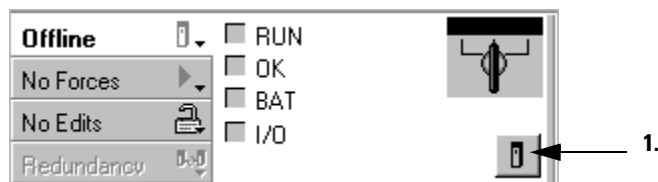


If you increase the system overhead time slice to 33 %, unscheduled communication occurs every 2 ms of continuous task time for 1 ms.

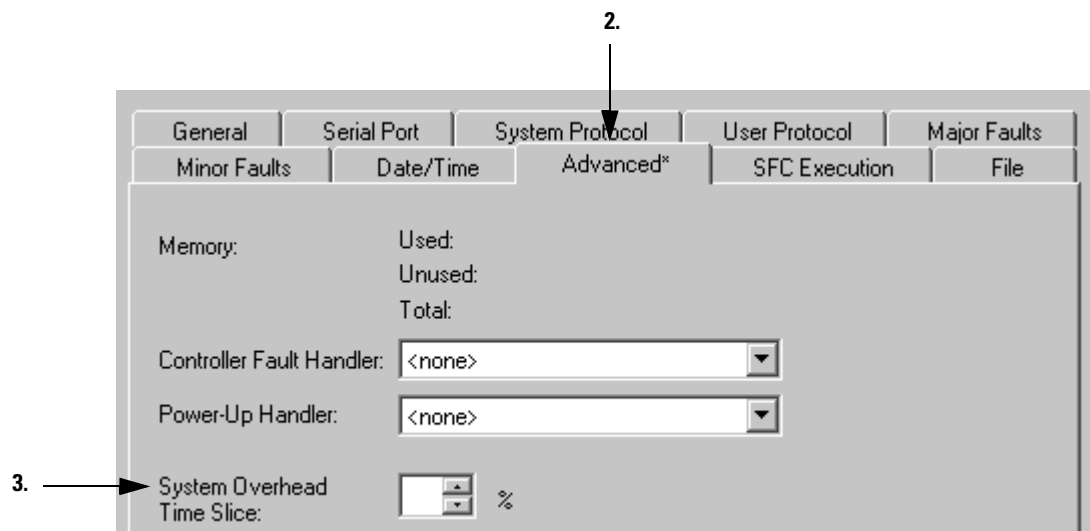


Enter a System Overhead Time Slice

To change the system overhead time slice:



1. On the Online toolbar, click controller properties button.
2. Click the *Advanced* tab.



3. Type or select a value for the system overhead time slice.

4. Choose 

Make All Your Tasks Periodic

If the controller contains only a periodic task or tasks, the system overhead time slice value has no effect. Unscheduled communication occurs whenever a periodic task is not running.

For example, if your task takes 50 ms to execute and you configure its update rate to 80 ms, the controller has 30 ms out of every 80 ms for unscheduled communication.



If you have multiple tasks, make sure that:

- 1. The execution time of a highest priority task is significantly less than its update rate.
- 2. The total execution time of all your tasks is significantly less than the update rate of the lowest priority tasks.

For example, in this configuration of tasks:

Task:	Priority:	Execution time:	Rate
1	higher	20 ms	80 ms
2	lower	30 ms	100 ms
total execution time: 50 ms			

- 1. The execution time of the highest priority task (Task 1) is significantly less than its update rate (20 ms is less than 80 ms).
- 2. The total execution time of all tasks is significantly less than the update rate of the lowest priority task (50 ms is less than 100 ms).

This generally leaves enough time for unscheduled communication. Adjust the update rates of the tasks as needed to get the best trade-off between executing your logic and servicing unscheduled communication.

■ Adjust CNB Usage

For each CNB module in a redundant chassis, keep CPU usage to less than 75 percent.

- Each redundant CNB module needs enough additional processing time for redundancy operations.
- At peak operations such as synchronization, redundancy uses an additional 8 percent (approximately) of the CPU of the CNB module.
- A total CPU usage that is higher than 75 percent may prevent a secondary chassis from synchronizing after a switchover.

To reduce the CPU usage of a module, you have these options:

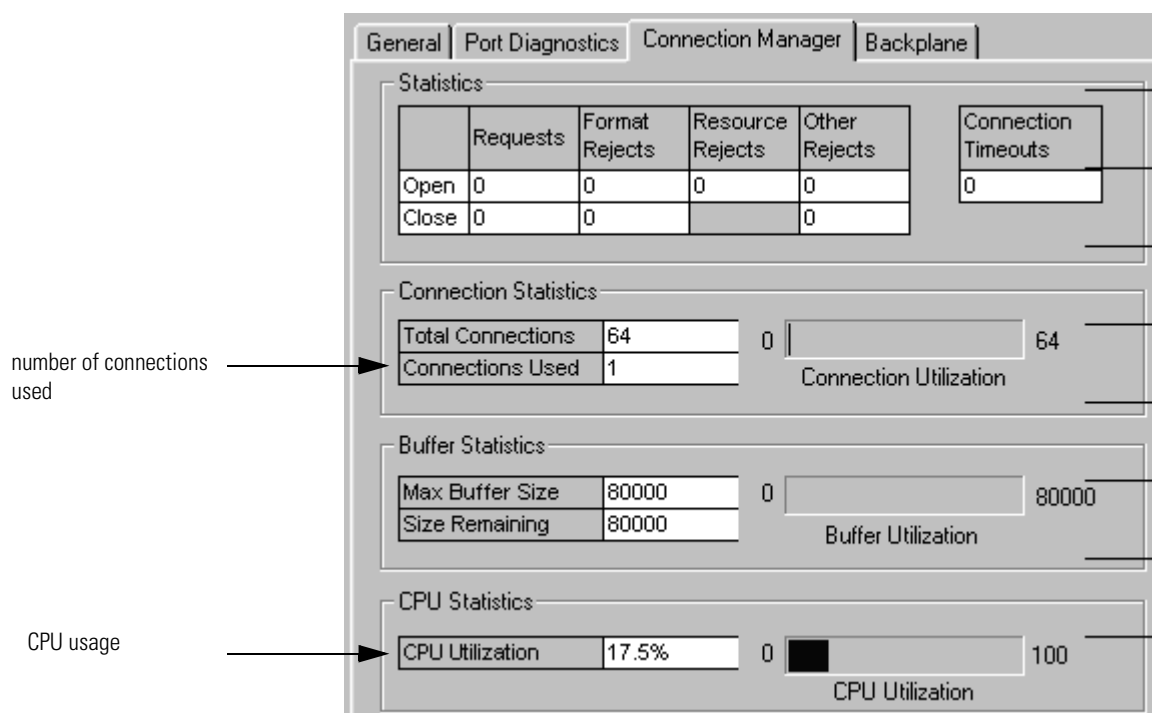
- Change the network update time (NUT) of the ControlNet network (Typically, increase the NUT to reduce the CPU usage of a CNB module.)
- Increase the requested packet interval (RPI) of your connections
- Reduce the number of connections to (through) the CNB
- Reduce the number of MSG instructions
- Add another CNB module to each redundant chassis

To get status information about a CNB module, you have these options:

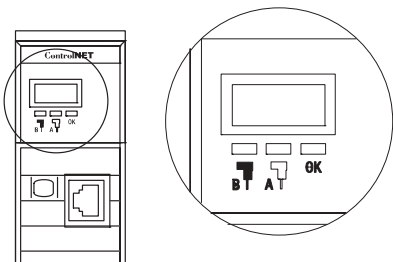
- ☐ Use RSLinx Software
- ☐ Look at the Four Character Display
- ☐ Send a Message to the CNB Module

Use RSLinx Software

1. Start RSLinx software.
2. Expand a network until you see your CNB module.
3. Right-click the module and choose *Module Statistics*.
4. Click the *Connection Manager* tab.



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Look at the Four Character Display

On the front of the 1756-CNB/D or -CNBR/D module, the four character display shows the following information:

For information about a CNB module:	Display:	Where:
percent of CPU usage	%Cxx	xx is the percent of CPU usage. The range for the display is 00 - 99 %.
number of open connections	nCxx	xx is the number of open connections that are in use by the CNB module.
number of unconnected buffers	nUxx	xx is the number of unconnected buffers that are in use by the CNB module.
state of the module's keeper function	Kpxx	xx is the state of the module's keeper function: If xx is: Then the keeper is:
	Ai	active network keeper with either: - invalid keeper information - or - keeper signature that does not match the keeper signature of the network
	Av	active network keeper with: - valid keeper information - keeper signature that defines the keeper signature of the network
	li	inactive network keeper with either: - invalid keeper information - or - keeper signature that does not match the keeper signature of the network
	lv	inactive network keeper with valid keeper information that matches the keeper signature of the network
	Oi	- powering up with invalid keeper information - or - offline with invalid keeper information
	Ov	- powering up with valid keeper information that may or may not match the keeper signature of the network - or - offline with valid keeper information that may or may not match the keeper signature of the network
number of times that the bandwidth of the module was exceeded	Bxnn	nn is the number of times that the bandwidth of the module was exceeded (bandwidth exceeded error) since the module was turned off or reset. You see this information only if the count is greater than zero.

Send a Message to the CNB Module

To use a Message (MSG) instruction to get the CPU usage of a CNB module, configure the MSG instruction as follows:

On this tab:	For this:	Type or select:											
Configuration	Message Type	CIP Generic											
	Service Code	4f											
	Class name	a1											
	Instance name	8											
	Attribute name	leave blank											
	Source	tag that uses a user-defined data type: <table><tr><th colspan="2">Members of the data type:</th><th rowspan="2">Tag value:</th></tr><tr><th>Name:</th><th>Data type:</th></tr><tr><td>offset</td><td>DINT</td><td>0</td></tr><tr><td>size_returned</td><td>INT</td><td>2</td></tr></table>	Members of the data type:		Tag value:	Name:	Data type:	offset	DINT	0	size_returned	INT	2
	Members of the data type:		Tag value:										
	Name:	Data type:											
offset	DINT	0											
size_returned	INT	2											
Num. Of Elements	6												
Destination	INT tag in which to store the CPU usage of the CNB module (0 - 99%.)												
Communication	Path	1, slot_number where: slot_number is the slot number of the CNB module.											

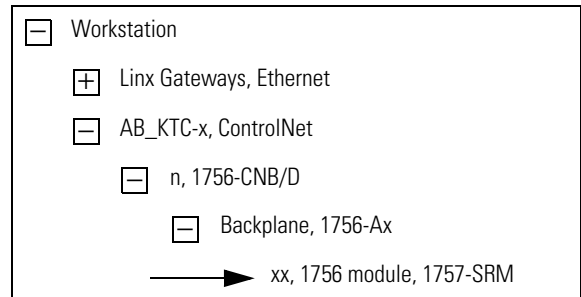
Export the SRM Event Log to Microsoft® Excel

To export specific events from the SRM event log to a Microsoft Excel spreadsheet:

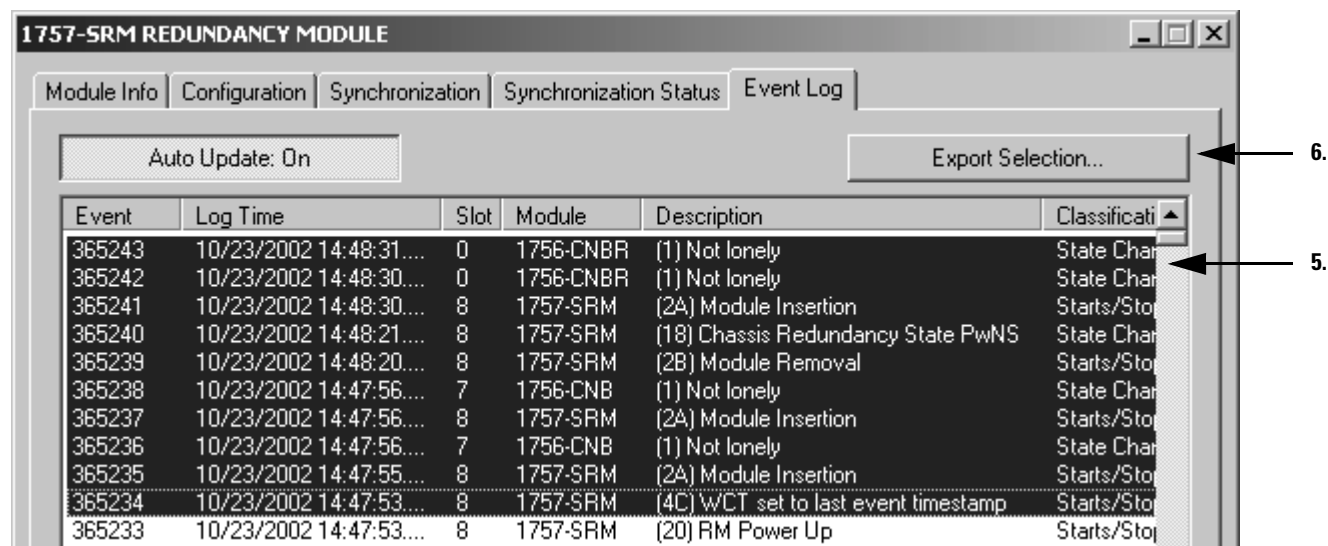
- ☐ Export Events to a CSV File
- ☐ Open and Format the CSV File

Export Events to a CSV File

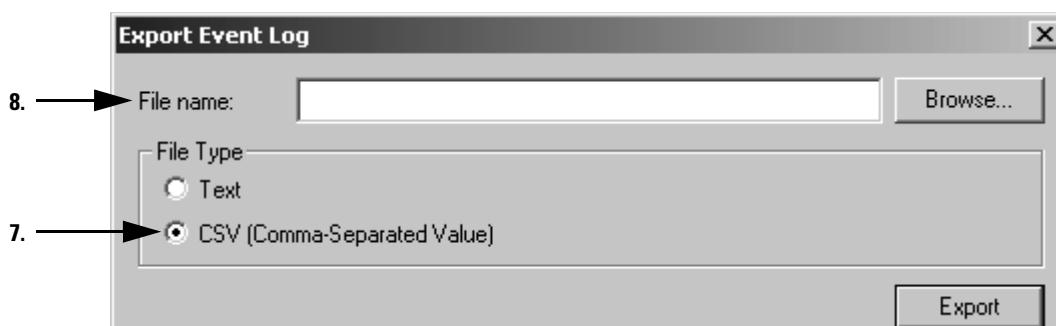
1. Display RSLinx software.
2. Expand the network until you see the 1757-SRM module in the primary chassis.



3. Right-click the 1757-SRM module and select *Module Configuration*.
4. Click the *Event Log* tab.



5. Select the events that you want to export, as follows:
 - a. Click the first event that you want to export.
 - b. Press and hold [Shift] and click the last event that you want to export.
6. Choose *Export Selection*.



7. Choose *CSV (Comma-Separated Value)*.
8. Supply a location and file name for the export file.
9. Choose *Export*.

Open and Format the CSV File

- 1. In Microsoft Excel software, open the .CSV file.
- 2. For the *Log Time* column, display the *Format Cells* dialog box.

A	B	C
Event	Log Time	Slot
1894564	12:15.0	5 1
1894563	12:15.0	5 1
1894562	12:10.0	5 1
1894561	12:10.0	5 1
1894560	11:32.8	5 1
1894559	11:32.1	5 1
1894558	11:24.6	4 1
1894557	11:23.3	5 1
1894556	11:21.3	4 1
1894555	11:21.3	5 1
1894554	11:21.2	5 1
1894553	11:10.9	5 1

Format Cells

Number

Alignment

Font

Border

Patterns

Protection

Category:

General

Number

Currency

Accounting

Date

Time

Percentage

Fraction

Scientific

Text

Special

Custom

Sample

Log Time

Type:

General

0

0.00

#,##0

#,##0.00

#,##0_);(,##0)

#,##0_);[Red](,##0)

Delete

Type the number format code, using one of the existing codes as a starting point.

- 3. From the *Category* list, select *Custom*.
- 4. In the *Type* box, enter the following format:

m/d/yyyy h:mm:ss.000

Configure the Auto-Synchronization Option

The Auto-Synchronization option determines when the 1757-SRM modules attempt to synchronize the controllers.

Choose an Auto-Synchronization Option

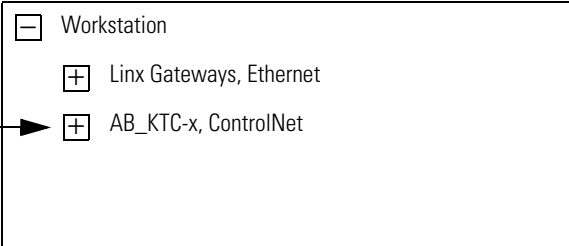
If you want the SRM modules to:	Then choose this Auto-Synchronization option:	Notes:
always try to synchronize the controllers	Always (default)	This is the typical option.
- always try to synchronize the controllers until you manually disqualify the secondary chassis - once you disqualify the secondary chassis, never try to synchronize the controllers until you manually synchronize the controllers	Conditional	Use this option if you frequently expect to manually toggle in and out of the disqualified condition. With this option: - When you synchronize the controllers, the SRM modules try to keep the controllers synchronized. - When you disqualify the secondary chassis, the SRM modules no longer try to keep the controller synchronized.
never try to synchronize the controllers	Never	You can still manually synchronize the controllers.

Configure the Auto-Synchronization Option

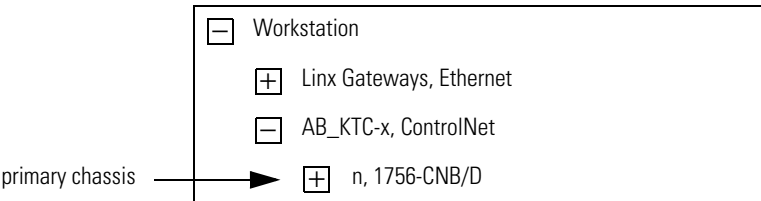
1. Display RSLinx software.
2. From the *Communications* menu, choose *RSWho*.

To expand a network one level, do one of the following:

- Double-click the network.
- Select the network and press the → key.
- Click the + sign.



3. Navigate to the CNB module of the primary chassis. The primary chassis uses the node to which its rotary switches are set.



- 1



- 7



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Get System Values

You can use a GSV instruction in your ladder logic to get system values for your redundancy system. You can then display that information on an HMI screen.

The REDUNDANCY object provides the following status information about the redundancy system.

For this information:	Get this attribute:	Data Type:	GSV/SSV:	Description:	
redundancy status of the entire chassis	ChassisRedundancy State	INT	GSV	If: 16#1	Then: power-up or undetermined
				16#2	primary with synchronized secondary
				16#3	primary with disqualified secondary
				16#4	primary with no secondary
redundancy state of the partner chassis	PartnerChassis RedundancyState	INT	GSV	If: 16#8	Then: synchronized secondary
				16#9	disqualified secondary with primary
redundancy status of the controller	ModuleRedundancy State	INT	GSV	If: 16#1	Then: power-up or undetermined
				16#2	primary with synchronized secondary
				16#3	primary with disqualified secondary
				16#4	primary with no secondary
				16#6	primary with synchronizing secondary
redundancy state of the partner	PartnerModule RedundancyState	INT	GSV	If: 16#7	Then: synchronizing secondary
				16#8	synchronized secondary
				16#9	disqualified secondary with primary
results of the compatibility checks with the partner controller	CompatibilityResults	INT	GSV	If: 0	Then: undetermined
				1	no compatible partner
				2	fully compatible partner
status of the synchronization (qualification) process	Qualification InProgress	INT	GSV	If: -1	Then: Synchronization (qualification) is not in progress.
				0	unsupported
				1 - 99	For modules that can measure their completion percentage, the percent of synchronization (qualification) that is complete.
				50	For modules that <i>cannot</i> measure their completion percentage, synchronization (qualification) is in progress.
				100	Synchronization (qualification) is complete.

For this information:	Get this attribute:	Data Type:	GSV/SSV:	Description:	
keyswitch settings of the controller and its partner match or do not match	KeyswitchAlarm	DINT	GSV	If:	Then:
				0	one of the following: - The keyswitches match. - No partner is present.
				1	keyswitches do not match
position of the keyswitch of the partner	PartnerKeyswitch	DINT	GSV	If:	Then the keyswitch is in:
				0	unknown
				1	RUN
				2	PROG
				3	REM
status of the minor faults of the partner (if the ModuleRedundancyState indicates that a partner is present)	PartnerMinorFaults	DINT	GSV	This bit:	Means this minor fault:
				4	problem with an instruction (program)
				6	periodic task overlap (watchdog)
				9	problem with the serial port
				10	low battery
mode of the partner	PartnerMode	DINT	GSV	If:	Then:
				16#0	power up
				16#1	program
				16#2	run
				16#3	test
				16#4	faulted
				16#5	run-to-program
				16#6	test-to-program
				16#7	program-to-run
				16#8	test-to-run
				16#9	run-to-test
				16#A	program-to-test
				16#B	into faulted
				16#C	faulted-to-program
In a pair of redundant chassis, identification of a specific chassis without regard to the state of the chassis.	PhysicalChassisID	INT	GSV	If:	Then:
				0	unknown
				1	Chassis A
				2	Chassis B
slot number of the 1757-SRM module in this chassis	SRMSlotNumber	INT	GSV		

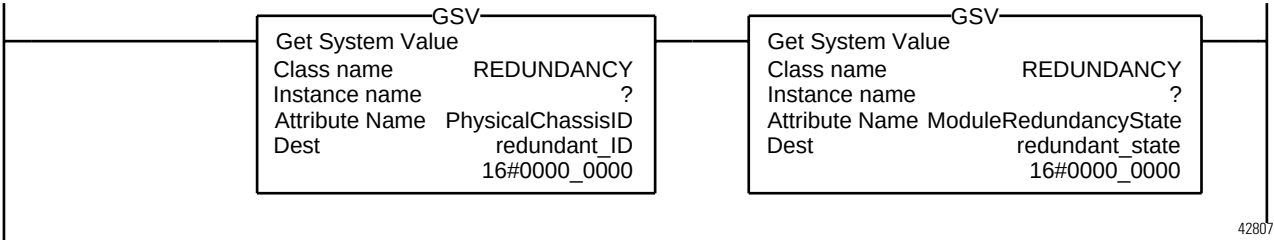
For this information:	Get this attribute:	Data Type:	GSV/SSV:	Description:			
Number of DINTs that were or would have been transferred	LastDataTransfer Size	DINT	GSV	This attribute is only valid on a primary controller that is configured for redundancy.			
				If:	Then this value is the:		
				a synchronized partner is present	amount of data that was last transferred to the partner, specified in DINTs		
				no partner is present	amount of data that would have been last transferred to a synchronized partner, specified in DINTs		
Maximum number of DINTs that were or would have been transferred	MaxDataTransfer Size	DINT	GSV	Maximum value of the LastDataTransfer Size attribute			
			SSV	- This attribute is only valid on a primary controller that is configured for redundancy. - To reset this value, use an SSV instruction with a Source value of 0.			
			If:	Then this value is the:			
			a synchronized partner is present	maximum amount of data that was transferred to the partner, specified in DINTs			
				<table><tr><td>no partner is present</td><td rowspan="2">maximum amount of data that would have been last transferred to a synchronized partner, specified in DINTs</td></tr><tr><td>a disqualified partner is present</td></tr></table>	no partner is present	maximum amount of data that would have been last transferred to a synchronized partner, specified in DINTs	a disqualified partner is present
no partner is present	maximum amount of data that would have been last transferred to a synchronized partner, specified in DINTs						
a disqualified partner is present							

For more information on the status information that you can access with the GSV instruction, see *Logix5000 Controllers General Instructions Reference Manual*, publication 1756-RM003.

EXAMPLE

Get system values

The first GSV instruction gets the label of the chassis that is currently the primary chassis and stores the value in *redundant_ID*. The second GSV instruction gets the redundancy state of the controller and stores the value in *redundant_state*.



Where:	Is:
<i>redundant_ID</i>	Tag to store the chassis label. The label tells you which chassis is acting as the primary chassis: • Data type is DINT. • Display style is Hex.
<i>redundant_state</i>	Tag to store the value of the redundancy state of the controller: • Data type is DINT. • Display style is Hex.

■ Send a Message to an SRM Module

IMPORTANT

Send only unconnected messages to a 1757-SRM module.

Leave the *Connected* check box clear (unchecked).



You can use ladder logic to perform the following actions:

- initiate a switchover
- disqualify the secondary controller
- synchronize the secondary controller
- set the clock of the SRM module

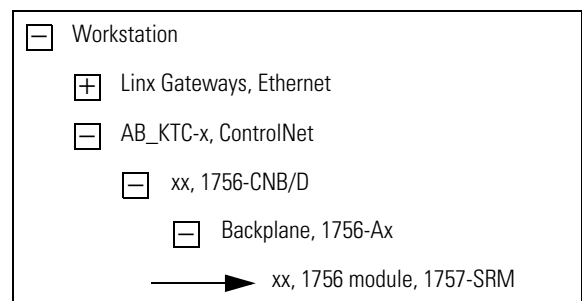
To send a message to a module:

- ☐ Configure the 1757-SRM Module
- ☐ Enter the Message Instruction
- ☐ Configure the Message Instruction

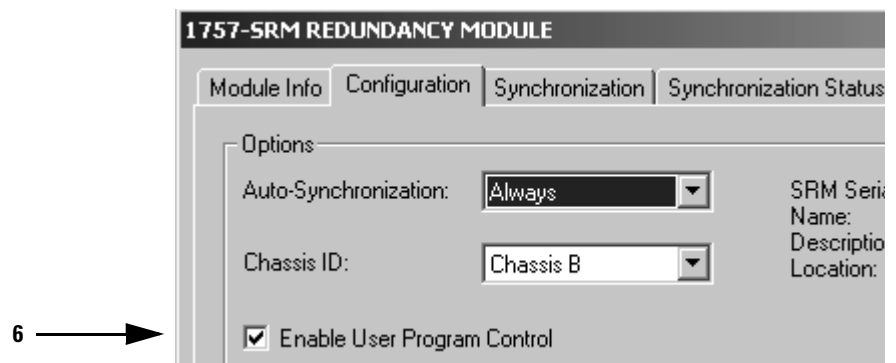
Configure the 1757-SRM Module

To send a message to an 1757-SRM module, configure the module to respond to ladder logic messages:

1. Start RSLinx software.
2. From the *Communications* menu, choose *RSWho*.
3. Expand the network until you see the SRM module in the primary chassis.



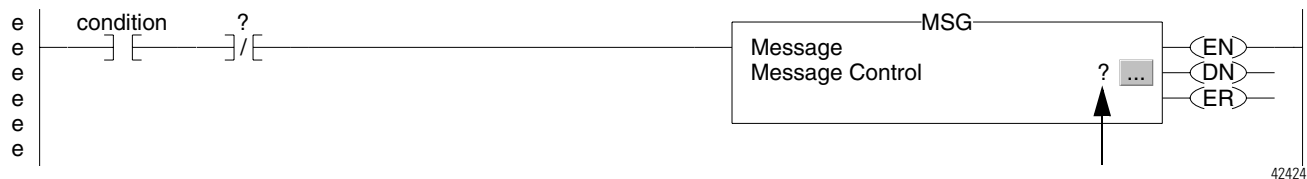
4. Right-click the 1757-SRM module and select *Module Configuration*.
5. Click the *Configuration* tab.



6. Select the *Enable User Program Control* check box. This is the default setting.
7. Choose *OK*.

Enter the Message Instruction

1. Open the RSLogix 5000 project.
2. Enter a MSG instruction and associated input instruction (s).



3. In the MSG instruction, type a name for the message control tag and press the *Enter* key.
4. In the MSG instruction, right-click the message control tag and select *New tag_name*.



5. Enter *message.EN*.

where:

message is the message control tag from step 3.

Configure the Message Instruction

1. In the MSG instruction, click .
2. Select a configuration for the message:

Table 5.3 Message to a Module

If you want to:	On this tab:	For this item:	Type or select:
initiate a switchover	Configuration	Message Type	<i>CIP Generic</i>
		Service Code	4e
		Class name	bf
		Instance name	1
		Attribute name	leave blank
		Source	DINT tag with a value of 1
		Num. Of Elements	4
		Destination	leave blank
	Communication	Path	1, <i>slot_number</i> where: <i>slot_number</i> is the left-hand slot number of the 1757-SRM module.
		Connected check box.	Leave the <i>Connected</i> check box clear (unchecked). You can send only unconnected messages to a 1757-SRM module.
disqualify the secondary controller	Configuration	Message Type	<i>CIP Generic</i>
		Service Code	4d
		Class name	bf
		Instance name	1
		Attribute name	leave blank
		Source	DINT tag with a value of 1
		Num. Of Elements	4
		Destination	leave blank
	Communication	Path	1, <i>slot_number</i> where: <i>slot_number</i> is the left-hand slot number of the 1757-SRM module.
		Connected check box.	Leave the <i>Connected</i> check box clear (unchecked). You can send only unconnected messages to a 1757-SRM module.

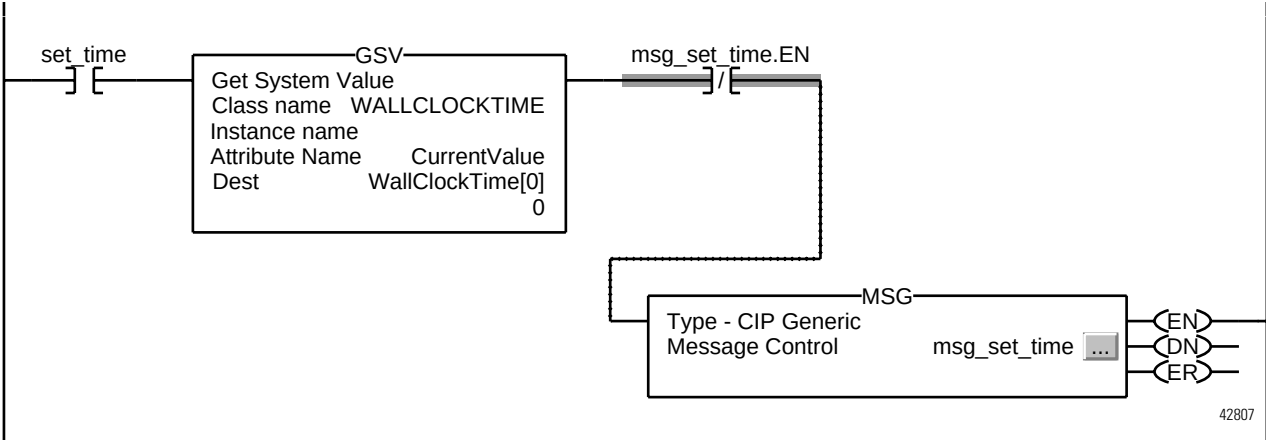
Table 5.3 Message to a Module (Continued)

If you want to:	On this tab:	For this item:	Type or select:
synchronize the secondary controller	Configuration	Message Type	<i>CIP Generic</i>
		Service Code	4c
		Class name	bf
		Instance name	1
		Attribute name	leave blank
		Source	DINT tag with a value of 1
		Num. Of Elements	4
		Destination	leave blank
	Communication	Path	1, <i>slot_number</i> where: <i>slot_number</i> is the left-hand slot number of the 1757-SRM module.
		Connected check box.	Leave the <i>Connected</i> check box clear (unchecked). You can send only unconnected messages to a 1757-SRM module.
set the clock of the SRM module	Configuration	Message Type	<i>CIP Generic</i>
		Service Code	10
		Class name	8b
		Instance name	1
		Attribute name	1
		Source	<i>WallClockTime [0]</i> where: <i>WallClockTime</i> is a DINT[2] array that stores the CurrentValue of the WALLCLOCKTIME object.
		Num. Of Elements	8
		Destination	leave blank
	Communication	Path	1, <i>slot_number</i> where: <i>slot_number</i> is the left-hand slot number of the 1757-SRM module.
		Connected check box.	Leave the <i>Connected</i> check box clear (unchecked). You can send only unconnected messages to a 1757-SRM module.

EXAMPLE

Set the clock of the 1757-SRM module

When *set_time* is on, the GSV instruction gets the current value of the WALLCLOCKTIME object and stores the value in the *WallClockTime* array (64 bits). The message instruction then sends the value to the SRM module.



Store or Load a Project Using Nonvolatile Memory

Nonvolatile memory lets you keep a copy of your project on the controller.

Term:	Description:
nonvolatile memory	Memory of the controller that retains its contents while the controller is without power or a battery.
store	To copy a project to the nonvolatile memory of the controller. This overwrites any project that is currently in the nonvolatile memory.
load	To copy a project from nonvolatile memory to the user memory (RAM) of the controller. This overwrites any project that is currently in the controller.

In a redundant system, you can store or load a project only while the secondary chassis is disqualified.

If you want to do this in a redundant system:	Do this:						
Store a Project	- Does the primary controller already contain the project that you want to store? <table> <tr> <th>If:</th><th>Then:</th></tr> <tr> <td>yes</td><td>Go to step 2.</td></tr> <tr> <td>no</td><td>Download the project to the primary controller.</td></tr> </table> - Place the primary controller in program mode (program or remote program). - In the Module Configuration properties for one of the 1757-SRM modules, set the <i>Auto-Synchronization</i> option = <i>Conditional</i>. - Disqualify the secondary chassis. - In the primary controller, store the project. For step-by-step procedures on how to store a project, see <i>Logix5000 Controllers Common Procedures</i>, publication 1756-PM001. - Synchronize the controllers. - Initiate a switchover. - Disqualify the new secondary chassis. - In the new primary controller, store the project. - Synchronize the controllers. - In the Module Configuration properties for one of the 1757-SRM modules, set the <i>Auto-Synchronization</i> option = the desired option.	If:	Then:	yes	Go to step 2.	no	Download the project to the primary controller.
If:	Then:						
yes	Go to step 2.						
no	Download the project to the primary controller.						
Load a Project—User Initiated	- Disqualify the secondary chassis. - Go online to the primary controller. - In the primary controller, load the project. For step-by-step procedures on how to load a project, see <i>Logix5000 Controllers Common Procedures</i>, publication 1756-PM001. - Synchronize the controllers.						
Load a Project—On Power Up	This Load Image option works the same as in a non-redundant system. When the controller loads a project on power up, it does so before it activates the redundancy feature.						
Load a Project—On Corrupt Memory	This Load Image option works the same as in a non-redundant system. When the controller loads a project due to corrupt memory, it does so before it activates the redundancy feature.						

Update a Module

Use the following steps to upgrade the revision of your redundant modules. This procedure minimizes the time your process is down for the upgrade.

IMPORTANT

Do not connect your computer to the ControlNet network via the network access port on a CNB module in the primary chassis. When you turn off power to the chassis, you will lose access to the network.

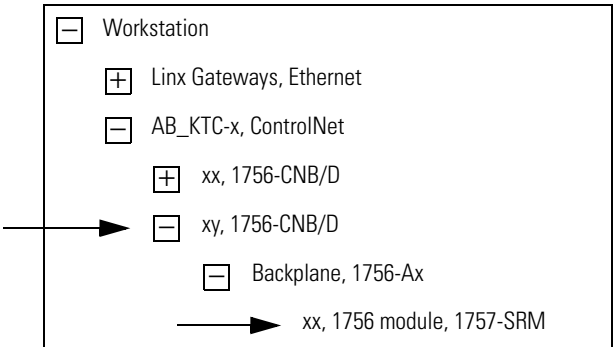
To update a module:Disqualify the Secondary Chassis

- ☐ Upgrade the Required Firmware of the Secondary Chassis
- ☐ Make the Secondary Controller the New Primary Controller
- ☐ Upgrade the Other Redundant Chassis
- ☐ Change the Auto-Synchronization Option to ALWAYS

Disqualify the Secondary Chassis

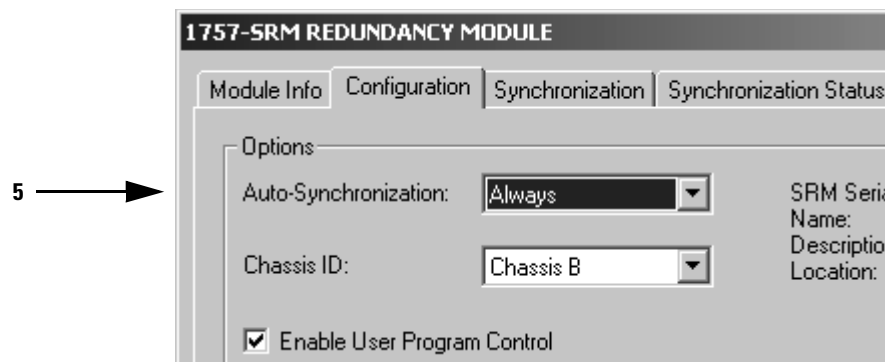
1. Start RSLinx software.
2. Find the SRM module in the secondary chassis.

The secondary chassis is one node greater than the primary chassis.



3. Right-click the 1757-SRM module and select *Module Configuration*.

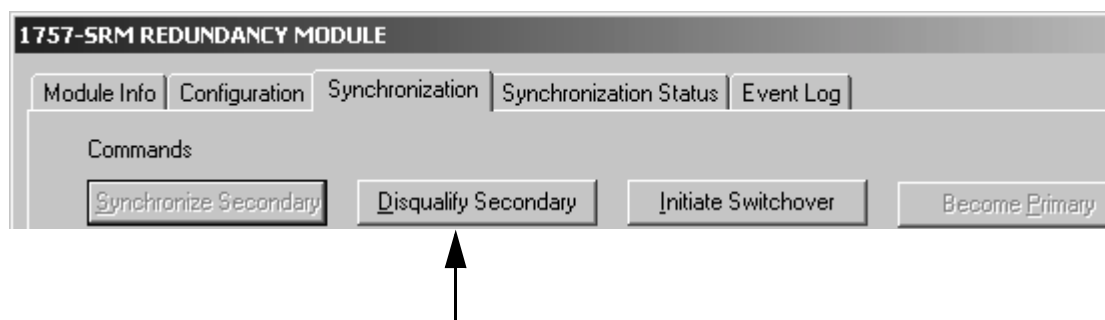
4. Click the *Configuration* tab.



5. Select *NEVER*.

6. Choose *Apply* and then *Yes* to confirm.

7. Click the *Synchronization* tab.



8. Choose *Disqualify Secondary*.

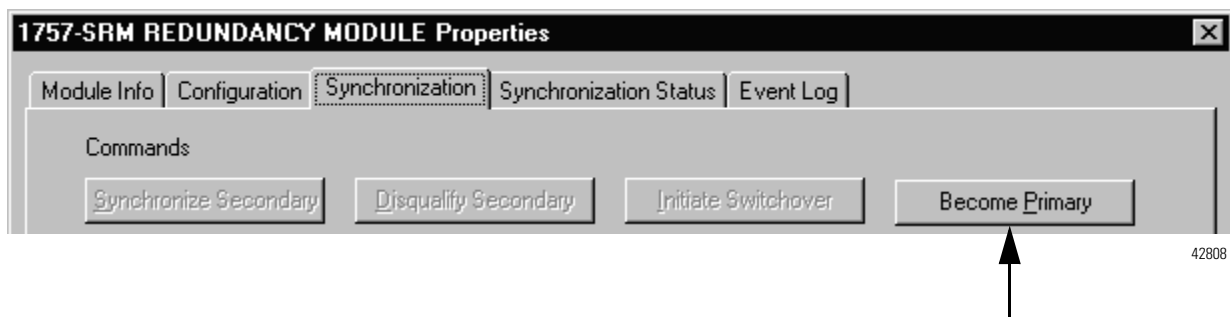
9. Choose *Yes* to confirm.

Upgrade the Required Firmware of the Secondary Chassis

See the *ControlLogix Controller and Memory Board Installation Instructions*, publication 1756-IN101.

Make the Secondary Controller the New Primary Controller

1. Start RSLogix 5000 software.
2. Download the project to the secondary controller.
3. When it is safe to stop the control of your system, change the primary controller to Program Mode.
4. Turn off power to the primary chassis.
5. Go to the 1757-SRM properties of the secondary chassis.



6. Choose *Become Primary*.
7. In RSLogix 5000 software, go online to the new primary controller.
8. The controller is faulted. When a disqualified secondary controller becomes a primary controller, the controller experiences a major fault.
9. From the *Communications* menu, choose *Clear Faults*.
10. To start control of the process, from the *Communications* menu, choose *Run Mode*.

Upgrade the Other Redundant Chassis

1. Turn on power to the other redundant chassis.
2. Upgrade the required firmware of the chassis.

Change the Auto-Synchronization Option to *ALWAYS*

- 1.** Go to RSLinx software.
- 2.** Find the SRM module in the primary chassis and open the properties of the module.
- 3.** On the Configuration tab, change the Auto-Synchronization Option to *ALWAYS*.
- 4.** Choose *OK*.

Develop the Bill of Materials

Redundant Controller Chassis

The ControlLogix redundancy system requires the following hardware for your controllers:

✓	Qty	Item	Cat number
	2	chassis	1756-A4, -A7, -A10, -A13, or -A17
	2	power supply	1756-PA72, -PB72, -PA75, or -PB75
	2	controller	1756-L55M13, -L55M14, -L55M16, -L55M23, or -L55M24
	2	ControlNet bridge module	1756-CNB/D or -CNBR/D
	2	redundancy module	1757-SRM
	1	fiber optic cable	1757-SRC1, -SRC3, -SRC10, -SRC50, or -SRC100

Additional Materials

You also need the following materials. The actual items depend on the design and lay-out of your system.

✓	Qty	Item	Cat number	Notes
		chassis or DIN rails	as required for your I/O modules	For ControlLogix chassis, redundant power supplies are available as an option: - For a redundant power supply kit, order catalog number 1756-PAR or 1756-PBR. - Each kit contains two redundant power supplies, cable, and adapter.
		ControlNet adapters	as required for your chassis or DIN rail	- You need an adapter for each remote chassis or rail. - If you are using a redundant ControlNet network, order the redundant (R) version of each adapter. - You need at least two ControlNet nodes in addition to the CNB modules in the redundant chassis pair.
		ControlNet tap	1786-TPS, -TPR, -TPYS, or -TPYR	If you are using a redundant ControlNet network, you need two taps for each device on your ControlNet network.
		RG-6 coaxial cable	1786-RG6 or -RG6F	
		terminator	1786-XT	You need 2 terminators for each ControlNet segment.

✓	Qty	Item	Cat number	Notes
		RSLogix 5000 software		• For catalog numbers, see the <i>ControlLogix Selection Guide</i>, publication 1756-SG001 • For compatible revisions of firmware and software, see the <i>ControlLogix Redundancy System Release Notes</i>, publication 1756-RN582.
		RSLinx Lite software		
		RSNetWorx for ControlNet software		

Convert an Existing System to Redundancy

Introduction

If you are adding redundancy to an existing system, follow these suggestions:

- If you change the node number of a CNB module, you may affect messages, tags, or listen-only connections in other devices. Choose node numbers that have the least impact on existing communications.
- If your existing system contains local I/O modules, you still need two additional chassis.
 - A redundant system can use only I/O that is in a remote chassis (i.e., not in the same chassis as the controller).
 - We recommend that you move the existing 1756-L55Mxx controller from the original chassis and place it in a redundant chassis.

Convert Local Modules to Remote Modules

If you are converting an existing system to a redundant system:

And the system:	Then:
contained only I/O modules that were not in the same chassis as the controller	You do not have to change the I/O configuration of the controller.
contained local I/O modules	Use the procedures in this section to convert the configuration of local modules to remote modules.

To convert a local module to a remote module:

- ☐ Re-Configure the Local I/O Modules
- ☐ Replace Local I/O Tags
- ☐ Replace any Aliases to Local I/O Tags

Re-Configure the Local I/O Modules

1. If you have not already done so, add the CNB module of the remote chassis to the I/O configuration of the controller. See the *ControlLogix System User Manual*, publication 1756-UM001.

I/O Configuration

[x] 1756-xxx name_of_local_module ← Cut local I/O modules from here.

[x] 1756-CNB/x name_of_local_CNB

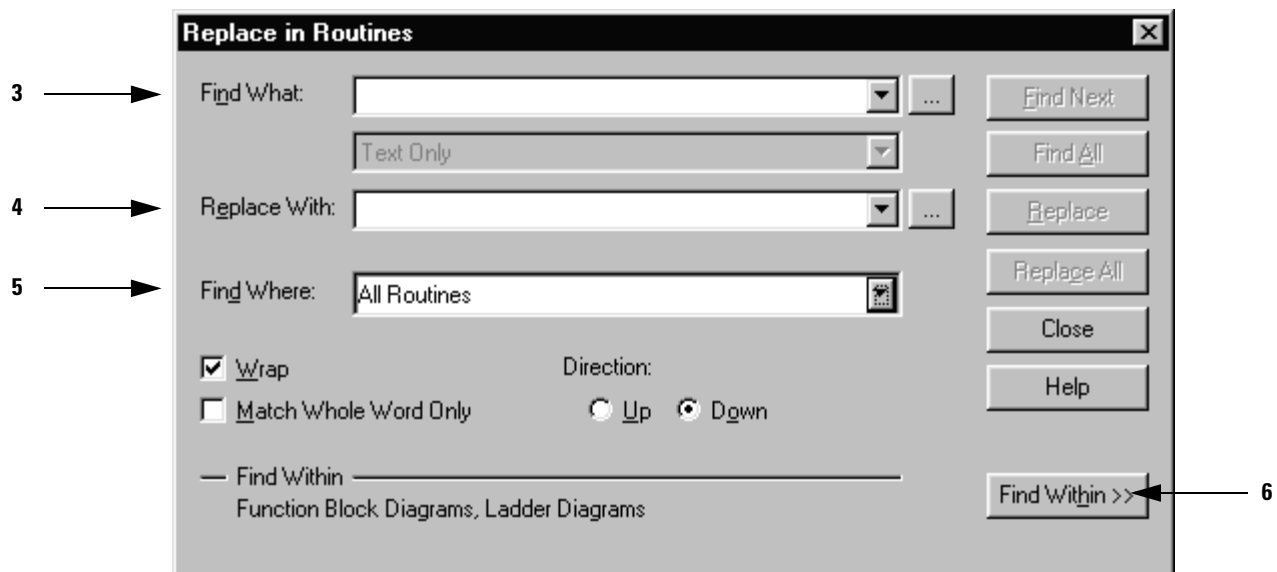
z [x] 1756-CNB/x name_of_remote_CNB ← Paste the I/O modules here.

2. In the controller organizer, cut the modules from the local I/O configuration and paste them into the remote CNB module. Cut and paste the following modules:
 - I/O
 - 1756-DHRIO
 - 1756-DNB
 - 1756-ENET or -ENB
 - 1756-MVI

Replace Local I/O Tags

1. Open a routine. If a routine is already open, click within the routine to activate the window.

2. Press the *Ctrl + H* keys (replace).



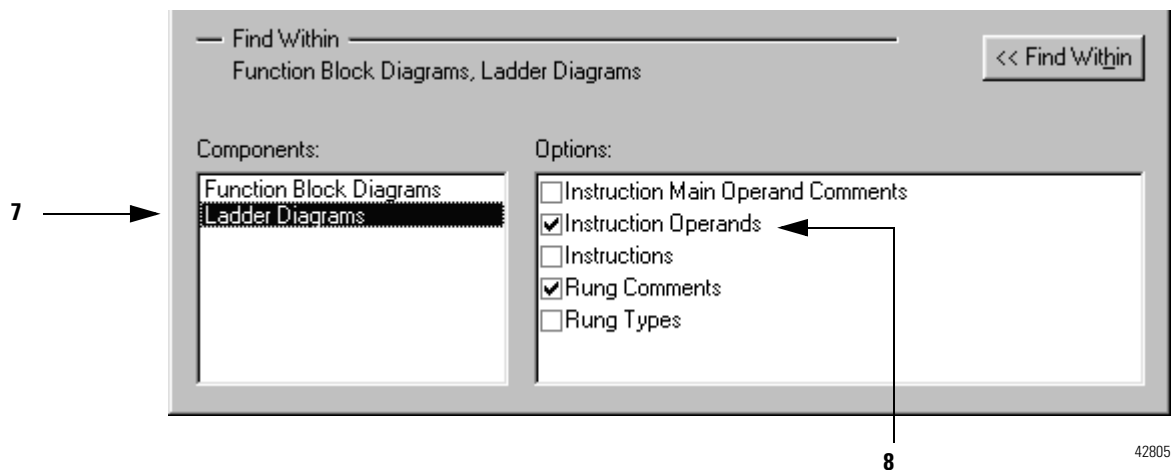
42804

3. Type *Local*.

4. Type the name of the CNB module that is in the remote chassis.

5. Select *All Routines*.

6. Choose *Find Within >>*.



42805

7. Select *Ladder Diagram*.

8. Check *Instruction Operands*.

9. Choose *Replace All*.

The Search Results tab displays the changes to the logic.

10. Choose *Close*.

The following example shows the results of replacing “Local” with “chassis_c”.

EXAMPLE

Replacing "Local" with "chassis_c"...

Searching through MainProgram - MainRoutine...

Replaced: Rung 0, XIC, Operand 0: XIC(Local:16:I.Data.0)

Replaced: Rung 0, OTE, Operand 0: OTE(Local:2:O.Data.0)

Replaced: Rung 1, XIC, Operand 0: XIC(Local:16:I.Data.1)

Replaced: Rung 1, OTE, Operand 0: OTE(Local:2:O.Data.1)

Replaced: Rung 2, XIC, Operand 0: XIC(Local:16:I.Data.2)

Replaced: Rung 2, OTE, Operand 0: OTE(Local:2:O.Data.2)

Replaced: Rung 8, OTE, Operand 0: OTE(Local:15:O.CommandRegister.Run)

Complete - 7 occurrence(s) found, 7 occurrence(s) replaced.

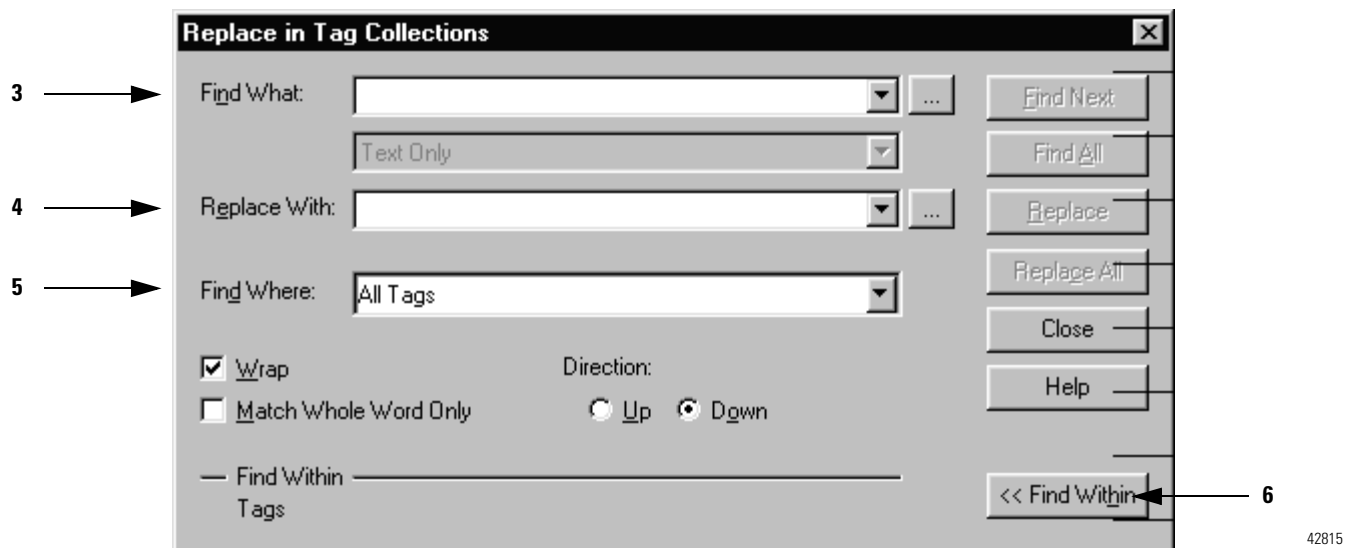
Replace any Aliases to Local I/O Tags

Are any of your tags an alias for an I/O device that was previously in a local chassis?

If:	Then:
Yes	Go to step 1.
No	Skip this procedure.

1. From the *Logic* menu, choose *Edit Tags*.

2. Press the *Ctrl + H* keys (replace).

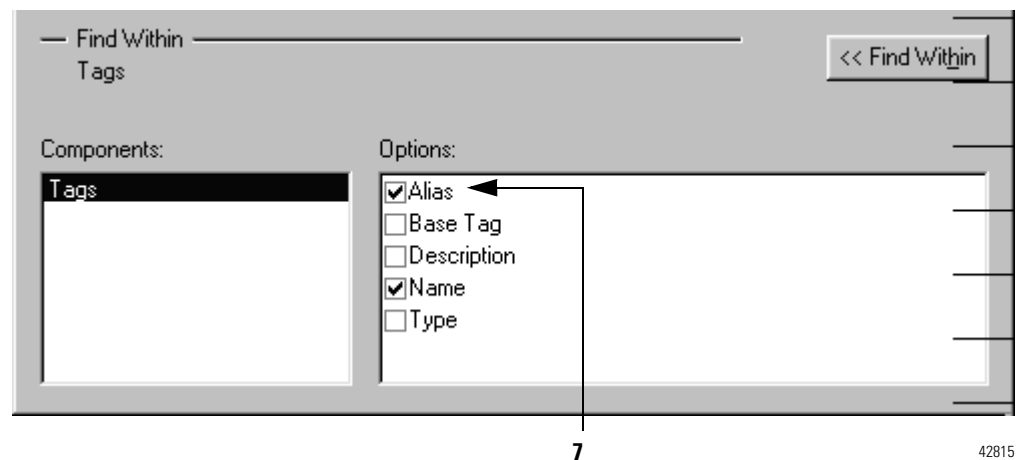


3. Type *Local*.

4. Type the name of the CNB module that is in the remote chassis.

5. Select *All Tags*.

6. Choose *Find Within >>*.



7. Check *Alias*.

8. Choose *Replace All*.

9. Choose *Close*.

Notes:

A

array 4-11
auto-synchronization 5-18

B

Basic Operation 1-1
bill of materials A-1
BOM A-1
BOOL 4-11
BSL instruction 4-15
BSR instruction 4-15

C

chassis
install 3-4
CNB module
4 character display 5-13
connection 2-6
install 3-5
node assignment 2-7
requirements 2-3
statistics 5-11
usage 5-11
communication
optimize 5-7
connection 2-6
consumed tag
configure 4-7
controller
connection 2-6
disqualify secondary 5-31
download project 3-12
install 3-5
nonvolatile memory 5-30
periodic task 5-10
program scan time 4-9, 4-10
project 4-1
requirements 2-3
synchronize 3-10, 5-6
system overhead time slice 5-8
watchdog time 4-20
ControlNet network
addresses 1-6
general lay-out 2-2
keeper signature 3-16, 5-4
node assignments 2-7
NUT 2-9
redundant media 2-5
schedule 3-13
ControlNet node addresses 1-6

conversion

to redundant system B-1

crossload 1-4, 1-5

D

data
crossload 1-5
integrity 4-15
organize 4-11
data type
recommendations 4-10, 4-11
DeviceNet network
design 1-7, 2-4
DINT 4-11
disqualified
overview 1-4
disqualify
secondary chassis 5-31
download 3-12

E

estimate program scan time 4-9
EtherNet/IP network
design 1-7, 2-4
event log
export 5-15
export
event log 5-15

F

FFU instruction 4-15
firmware
update 3-9, 5-31

G

Get System Value instruction 5-20
GSV instruction 5-20

H

HMI
configure tags 4-8
design recommendations 2-2
optimize communication 5-7

I

I/O
configure 4-6

- convert local to remote B-1
- placement 1-7, 2-4, 3-8
- redundant power supplies 2-6

import

- event log 5-15

initiate switchover 3-18**install**

- system components 3-1

INT 4-10, 4-11**K****keeper signature**

- check 3-16
- update 5-4

L

load a project from nonvolatile memory
5-30

M**message**

- send to SRM module 5-24

Message instruction 4-8**Microsoft Excel**

- import event log 5-15

MSG instruction 4-8**N****NAP** 1-3, 3-1**network access port**

- restrictions 1-3, 3-1

network update time 2-9**nonvolatile memory**

- load a project 5-30
- store a project 5-30

NUT. See ControlNet network**P****PanelView terminal**

- design recommendations 2-2

periodic task 5-10**power supplies**

- redundant 2-6

produced tag

- configure 4-7

program

- number of 4-10

program scan time 4-9

- minimize 4-10

- overview 1-5

project

- create and maintain 4-1
- download 3-12
- load 5-30
- store 5-30

Q

qualify. See synchronize

R**REAL** 4-11**REDUNDANCY object** 5-20**remote I/O network**

- design 1-7, 2-4

requested packet interval 4-6**RIO network**

- design 1-7, 2-4

S

scan time. See program scan time, task scan time

schedule a ControlNet network 3-13**SINT** 4-10, 4-11**SRM module**

- auto-synchronization 5-18
- configure 5-25
- disqualify secondary 5-31
- export event log 5-15
- initiate switchover 3-18
- install 3-5
- send message to 5-24
- synchronization status 3-18
- synchronize controllers 5-6

store a project to nonvolatile memory
5-30

switchover

- causes 1-2
- data integrity 4-15
- diagnose cause 5-2
- initiate 3-18
- test 3-17
- time for 2-11

synchronize

- controllers 5-6
- diagnose failure 3-18
- overview 1-4
- status 3-18
- synchronize controllers 3-10

system information

get 5-20

system overhead time slice 5-8**T****task**

number of 5-10

watchdog time 4-20

task scan time

determine 4-22

test

switchover 3-17

U**update firmware** 3-9, 5-31**user-defined data type** 4-11**W****watchdong time** 4-20**workstation**

connect to a NAP 1-3, 3-1

connection

A communication link between two devices, such as between a controller and an I/O module, PanelView terminal, or another controller. You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. Connections are allocations of resources that provide more reliable communications between devices than unconnected messages. See *direct connection*, *rack optimization connection*.

consumed tag

A tag that receives the data that is produced (broadcast) by another controller. Logix5000 controllers can produce and consume tags over an EtherNet/IP network, a ControlNet network, or a ControlLogix backplane. See *produced tag*.

crossload

The transfer of any or all of the contents of the primary controller to the secondary controller. This could be updated tag values, force values, online edits, or any other information about the project. A crossload occurs initially when the controllers synchronize and then repeatedly as the primary controller executes its logic.

direct connection

A direct connection is a real-time, data transfer link between the controller and an I/O module. The controller maintains and monitors the connection between the controller and the I/O module. Any break in the connection, such as a module fault or the removal of a module while under power, causes the controller to set fault status bits in the data area associated with the module. See *connection*, *rack optimization connection*.

disqualified

Indicates that the secondary control has failed to synchronize with the primary controller. If a secondary controller is disqualified, it is unable to take over control of the machine or process. You also have the option of manually disqualifying a secondary controller.

load

To copy a project from nonvolatile memory to the user memory (RAM) of the controller. This overwrites any project that is currently in the controller. See *nonvolatile memory*, *store*.

NAP

See *network access port (NAP)*.

network access port (NAP)

A port on a ControlNet device that lets you connect another device to a ControlNet network.

network update time (NUT)

The repetitive time interval in which data is sent over an EtherNet/IP or ControlNet network.

nonvolatile memory

Memory of the controller that retains its contents while the controller is without power or a battery. See *load*, *store*.

NUT

See *network update time (NUT)*.

primary chassis

The chassis that contains the primary controller.

primary controller

The controller that is currently controlling the machine or process.

produced tag

A tag that a controller is making available (broadcasting) for use by other controllers. See *consumed tag*.

rack optimization connection

For digital I/O modules, you can select rack optimization communication. A rack optimized connection consolidates connection usage between the controller and all the digital I/O modules on a rack (or DIN rail). Rather than having individual, direct connections for each I/O module, there is one connection for the entire rack (or DIN rail). See *connection*, *direct connection*.

requested packet interval (RPI)

When communicating over a network, this is the maximum amount of time between subsequent production of input data.

- Typically, this interval is configured in microseconds.
- The actual production of data is constrained to the largest multiple of the network update time that is smaller than the selected RPI.
- Use a binary multiple of the network update time (NUT). The binary multipliers are: 1, 2, 4, 8, 16, 32, 64, and 128.

For example, if the NUT is 5 ms, use an RPI of 5, 10, 20, 40 ms, etc.

See *network update time (NUT)*.

RPI

See *requested packet interval (RPI)*.

secondary chassis

The chassis that contains the secondary controller.

secondary controller

The controller that is standing by to take control of the machine or process.

SMAX

In a ControlNet network, the maximum scheduled address. The greatest node number to use scheduled communications on a ControlNet network.

store

To copy a project to the nonvolatile memory of the controller. This overwrites any project that is currently in the nonvolatile memory. See *load*, *nonvolatile memory*.

switchover

Transfer of control from the primary controller to the secondary controller. After a switchover, the controller that takes control becomes the primary controller. Its partner controller (the controller that was previously the primary controller) becomes the secondary controller.

synchronize

The process that readies a secondary controller to take over control if a failure occurs in the primary chassis. During synchronization, the 1757-SRM modules checks that the partner modules in the redundant chassis pair are compatible with each other. The SRM module also crossloads (transfers) the content of the primary controller to the secondary controller. Synchronization occurs when the secondary chassis powers up. It may also occur at other times.

system overhead time slice

Specifies the percentage of time (excluding the time for periodic tasks) that the controller devotes to unscheduled communication. Unscheduled communication includes:

- communicate with programming and HMI devices (such as RSLogix 5000 software)
- respond to messages
- send messages, including block-transfers
- re-establish and monitor I/O connections (such as RIUP conditions); this *does not* include normal I/O communications that occur during program execution
- bridge communication from the serial port of the controller to other ControlLogix devices via the ControlLogix backplane
- synchronize the secondary controller of a redundant system

The controller performs unscheduled communication for up to 1 ms at a time. The following table shows the ratio between the continuous task and unscheduled communication at various system overhead time slices:

At this time slice:	The continuous tasks runs for:	And unscheduled communication occurs for up to:
10%	9 ms	1 ms
20%	4 ms	1 ms
33%	2 ms	1 ms
50%	1 ms	1 ms

UMAX

In a ControlNet network, the maximum unscheduled address. The greatest node number that you will use on a ControlNet network.

watchdog

Specifies how long a task can run before triggering a major fault.

- Each task has a watchdog timer that monitors the execution of the task.
- A watchdog time can range from 1 ms to 2,000,000 ms (2000 seconds). The default is 500 ms.
- The watchdog timer begins to time when the task is initiated and stops when all the programs within the task have executed.
- If the task takes longer than the watchdog time, a major fault occurs. The time includes interruptions by other tasks.

Notes:



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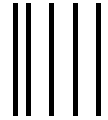
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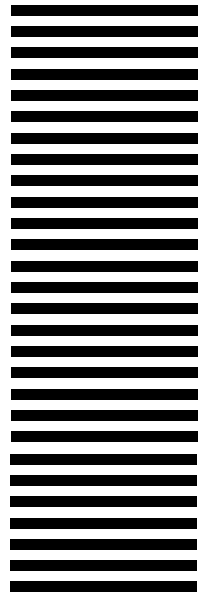
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